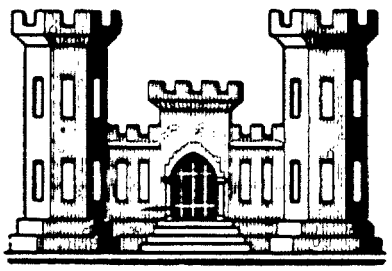
CAPE COD CANAL

BOURNE, MASSACHUSETTS

BOURNE HIGHWAY BRIDGE MAJOR REHABILITATION

DESIGN MEMORANDUM



U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS WALTHAM, MASS.

NOVEMBER 1963

U. S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM 54, MASS.

RESS REPLY TO:
IVISION ENGINEER

EFER TO FILE NO.

NEDGB

21 November 1963

SUBJECT: Cape Cod Canal - Bourne Highway Bridge - Major Rehabilitation - Design Memorandum

TO: Chief of Engineers
ATTN: ENGCW-E
Washington, D. C.

1. There is submitted for review and approval a Design Memorandum for the Major Rehabilitation of the Bourne Highway Bridge, Cape Cod Canal, Bourne, Massachusetts, in accordance with EM 1110-2-1150 and EM 1110-2-1152. The contract award for the construction of this project is scheduled for January 1964 contingent upon the appropriation of funds by the Congress of the United States.

2. The engineering and design for the Major Rehabilitation of the Bourne Highway Bridge is similar to the design for the Renovation of the Sagamore Highway Bridge. Spans 1, 2, and 3 are identical for both bridges except for the expansion joints. The Bourne Bridge has seven steel spans and two concrete abutments for a total length of 2,684 feet. The Sagamore Bridge has three steel spans and two concrete abutments for a total length of 1,833 feet. The decks of the two bridges are identical except for their lengths and expansion joints. Both bridges were constructed at the same time under the same contracts with identical materials. The condition of both bridges was similar prior to the rehabilitation of the Sagamore Bridge.

3. The contract plans and specifications for the Renovation of the Sagamore Highway Bridge were prepared by NED. The renovation was accomplished with Maintenance and Operations funds and was successfully completed in June 1962. The design concepts and construction scheduling proved to be adequate for the Sagamore Bridge and are believed to be adequate for the Bourne Bridge.

FOR THE DIVISION ENGINEER:

Incl (10 cys)
Design Memo

JOHN WM. LESLIE
Chief, Engineering Division

CAPE COD CANAL

BOURNE HIGHWAY BRIDGE

BOURNE, MASSACHUSETTS

DESIGN MEMORANDUM

MAJOR REHABILITATION

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LIST OF APPENDICES

A. PROJECT AUTHORIZATION

1. Authority. - The rehabilitation of the Bourne Highway Bridge is authorized by Section 2 of the River and Harbor Act of 21 January 1927, supplemented by the Public Works Act of 1933.

B. LOCATION AND DESCRIPTION

2. Location. - The bridge is located on Massachusetts Highway Route 28 over the Cape Cod Canal connecting Buzzards Bay and U. S. Highway 6 on the northerly side of the Canal and Bourne, Massachusetts on the southerly side. The bridge is near the west end of the canal approximately two miles from the Buzzards Bay Canal entrance and approximately six miles from the East end of the canal and the Cape Cod Bay entrance to the canal.

3. Description. - The bridge is a high-level, four lane fixed highway bridge, 2,384 feet long with navigation clearances of 480 feet horizontally and 135 feet vertically.

C. HISTORY OF BRIDGE

4. History of Bridge. - The bridge was constructed during the period 1933-1935. Funds were supplied by the Public Works Administration (PWA) and the construction was completed at a cost of approximately $1,500,000. Upon completion, the bridge received the 1935 Class "A" Award of Merit for "Most Beautiful Steel Bridges" from the American Institute of Steel Construction. The bridge has been periodically repainted and repaved and has received routine annual maintenance. It has satisfactorily served the purpose for which it was designed, but is now in need of a major rehabilitation.

D. DESCRIPTION OF ORIGINAL DESIGN

5. Original Design. - The bridge consists of seven steel spans with a combined length of 2,384 LF and two reinforced concrete abutments of 150 LF each for a total length of 2,684 LF. Span No. 1, the central span, has a vertical clearance of 135 feet above mean high water and a length of 616 LF. It is a trussed steel arch from which the deck is suspended by cable hangers. The remaining spans are steel trusses. The bridge deck is of reinforced concrete containing light-weight aggregate. The abutments were constructed of reinforced concrete containing normal-weight aggregate.

E. EFFECTS OF STORM DAMAGE

6. Effects of Storm Damage. - There is no evidence that the bridge has ever suffered storm damage.

F. PROGRESSIVE DETERIORATION

7. Progressive Deterioration. - The first indication of deterioration occurred on May 10, 1937 when a hole about 18 inches in diameter was found passing completely through the concrete deck on Span No. 1. An examination made at the time indicated that the concrete was less dense than it should have been at the point where the failure occurred. Alternate freezing and thawing had presumably distressed the concrete at the location and it disintegrated under traffic. Similar holes occurred in the deck of Span No. 4 in 1955 and Span No. 3 in 1963. All three holes were repaired without difficulty.

In 1937, it became evident that the porous bituminous concrete paving had allowed water to filter through the light-weight concrete deck. This leakage in turn led to staining and discoloration of the concrete on the underside of the concrete slab. The water seeping through the concrete also discolored the paint and caused some localized rusting of the structural steel. In a few locations, spalling of the concrete on the underside of the deck had occurred exposing portions of the bottom reinforcing steel.

A thorough condition survey was made and a report prepared in August 1937. On the basis of this report, a seal coat was applied to the bituminous concrete paving in 1938 in an attempt to correct the condition and reduce the rate of deterioration. The seal coat consisted of a layer of sheet asphalt 1/2 inch thick on which was placed a 1/2 inch thick wearing surface of asphalt coated pea stone. The seal coat undoubtedly reduced the rate, but did not substantially arrest the deterioration. The bridge deck was completely resurfaced in 1949.

In the ensuing years, the same pattern of deterioration continued until the present day and conditions now necessitate a major rehabilitation of the bridge deck. The underlying cause is the lack of an adequate waterproof membrane.

G. REPAIRS PREVIOUSLY MADE

8. Repairs Previously Made. - The following repairs and maintenance have been previously completed:

CONTRACT WORK

Year	Description	Amount
1938	Painting of Structural Steel	$11,125.00
1938	Seal Coat of Sheet Asphalt	8,840.00
1947	Painting of Structural Steel	52,150.00*
1949	Resurfacing of Deck-Bituminous Concrete	29,489.56
1951 & 1952	Painting of Structural Steel	54,814.00
1958	Painting of Structural Steel	44,494.36
1959	Repairs to Truss Bearings	5,065.00**

* Both Bourne and Sagamore Bridges
** Both Bourne and Sagamore Bridges (Bourne work very minor)

HIRED LABOR

Year	Description
1937	Repaired hole in concrete deck (Span No. 1)
1955	Repaired hole in concrete deck (Span No. 4)
1962 & 1963	Replaced sections of catwalk grating
1962 & 1963	Installed covers over roller bearings
1963	Repaired hole in concrete deck (Span No. 3)

ANNUAL MAINTENANCE

a. Cleaning, greasing and aligning roller bearings.
b. Patching concrete curbs and sidewalks.
c. Patching bituminous concrete roadway paving.
d. Spot painting of structural steel.
e. Repairs to expansion joints (welding and placing mastic compound).

H. PRESENT CONDITION OF STRUCTURE

9. Present Condition of Concrete Deck. - The present condition of the Bourne Bridge has been determined by visual examination of the structure; removal of cores from the bituminous overlay, concrete, and steel stringers; removal of sections of the bituminous pavement;

and evaluation of laboratory tests performed on concrete cores removed from the deck and abutments.

The visual examination of the structure indicates that there is general disintegration and spalling of the concrete directly under the curbs and gutters of both the east and west sides of the bridge where water and chemical salts used for snow and ice removal have accumulated in the gutters and filtered down through the concrete. These solutions have migrated along the reinforcing steel causing it to rust heavily and flake off the concrete. The spalled areas are approximately 1 inch deep with some local areas showing spalls as deep as 6 inches. The center line of the bridge, which contains a marble chip concrete marker strip, also shows indication of intermittent local distress evidenced by stains caused by leakage, minor rusting of the steel and minor spalling. The remaining portions of the deck show some local areas of hairline map and tension cracking with leakage evidenced by deposition of a secondary white salt deposit delineating the cracks. The areas adjacent to the expansion joints show the greatest distress, as would normally be expected, because the joints act as interceptors to back up the water migrating under the bituminous pavement.

The conditions apparent to visual examination of the structure have been verified by various methods consisting of a series of AX (1-15/16-inch) cores taken through the bituminous pavement, lightweight concrete and flanges of the silicon and carbon steel stringers; a series of 6-inch concrete cores removed to random check the quality of the concrete in the deck, abutments and wedge block; a series of 4-inch cores to delineate areas of decomposed concrete indicated by the random check; removal of sections of the bituminous pavement from the deck and abutments to ascertain the condition of the underlying concrete.

Examination of the AX core sections indicated that the top flanges of the steel stringers in the areas showing heavy stain have been rusted and pitted to a depth of approximately 1/32-inch, which will not impair the load-bearing capacity. Concrete core recovery from these explorations was poor because of the small diameter of the core and the breakup of the concrete due to the binding action of the steel cuttings. However, the concrete recovered did indicate the need for further investigation.

The 6-inch diameter cores were removed to obtain adequate samples for determining the quality of the concrete and the relationship of quality to depth of concrete. The cores were wedged off at

the bottom steel to preserve its integrity. The cores indicate that the light-weight "Haydite" concrete on the deck and the regular concrete of the abutment have been subjected to leaching water which has deposited to full depth, a white insoluble salt. Analysis of the salt indicates it may be in the form of a complex calcium oxide (see Plate No. A-2, Werby Laboratories, Inc. report). The deposition of the salt in depth indicates that the ultimate durability of the concrete is being impaired and points up the necessity for adequate waterproofing of the concrete deck to arrest the condition.

Compression tests performed on samples of concrete sawed from the cores indicate that the concrete has an average compressive strength of 6,305 PSI (see Appendix A-1 for results of compressive strength tests). The cores also indicate that there is one area of Span No. 6 where the concrete deck shows faulty original construction (low strength and density). The unconsolidated area of concrete has disintegrated to a degree that replacement of a section of the deck 20 feet by 26 feet will be necessary. This area was delineated by removing a series of 4-inch cores.

It is possible that additional areas of concrete may require removal and replacement during rehabilitation. This can only be determined with absolute certainty after the complete removal of the bituminous concrete pavement. However, all suspected areas were investigated by coring and pavement removal and the explorations indicate that the only area in need of replacement is the one located on Span No. 6.

Removal of sections of the bituminous concrete pavement indicates that there are local areas of honeycomb and porosity in the surface of the concrete deck as well as some surface laminate deterioration and concentrations of salt compounds. The removal of the bituminous concrete pavement by pneumatic equipment also indicated that the specifications should require a less aggressive method of removal. For this reason, the heater planer method will be specified.

10. Present Condition of Expansion and Deflection Joints. - The following description of the condition of the expansion and deflection joints starts at the north abutment and ends at the south abutment. The span and pier numbers are shown in Plate No. E-1. The inspection included first a topside examination of the roadway and joints followed by an inspection of the structural steel from the bottom side of the deck.

1st Joint - Angle Nosing. - North abutment at transition block. The nosing is continuous and in good condition and no repair work is required.

2nd Joint - Expansion. - Fifty-eight feet from transition block. The 10-inch cover plate is cut in two pieces and shows some deterioration at the joint.

3rd Joint - Expansion. - Fifty-seven feet from 2nd joint. The 10-inch cover plate is continuous and is in good condition.

4th Joint - Deflection. - Thirty-three feet from 3rd joint and at the beginning of Span No. 6. The joint is in good condition although several of the rivets are loose in the cover plate. The cover plate is 12 inches wide and in two pieces. The steel is in good condition although there is slight seepage and slight rusting.

5th Joint - Expansion. - At Pier No. 6 and at the beginning of Span No. 4. The plate is 18 inches wide and in two pieces. The plates are loose and the support plate beneath the cover plate has settled such that point bearing exists between the two surfaces. Steel shows leakage occurs and rusting is moderate in particular on the transverse girder.

6th Joint - Expansion. - At Pier No. 4 and at the beginning of Span No. 2. The joint cover plate is 6 feet wide and in four pieces. On the east side, the plate is loose and causes a thumping effect. The structural steel is rusted severely and an area exists where no paint has been applied. A number of rivets have rusted to such a point that replacement is essential. The finger plates and the transverse girder are heavily rusted.

7th Joint - Expansion. - Close to Pier No. 2 and at the beginning of Span No. 1. The joint has a 15-inch cover plate. The amount of expansion possible is small (less than 1/2 inch). The structural framing is heavily rusted. The concrete is deteriorated on each side of the joint and must be replaced.

8th Joint - Expansion. - Close to Pier No. 1 and at the beginning of Span No. 3. The joint has a 15-inch cover plate that is in relatively good condition although slight thumping occurs on the east side. The structural framing is moderately rusted on each side of the joint for the full length of the joint.

9th Joint - Expansion. - At Pier No. 3 and at the beginning

of Span No. 5. The joint cover plate is 6 feet wide, made up of four pieces, and is in good condition. At the transition, a small drop occurs which creates some vibration. At the sidewalk, the plate over the expansion joint passes underneath lamp post base No. 12W. Structural steel below the joint is heavily rusted which includes the transverse girders and their stiffeners.

10th Joint - Expansion. - At Pier No. 5 and at the beginning of Span No. 7. The 15-inch cover plate is loose and creates vibration. The plate is cut in several pieces and needs to be replaced. The 3-1/2 inch angle nosing on the east curb is in poor condition. The structural steel has a little rust, but is in good condition.

11th Joint - Deflection. - At the beginning of the South Abutment. The cover plate and its rivets are loose. The plate is cut in several pieces and has settled below the roadway surface. When a heavy vehicle strikes the joint, the bridge vibrates. The joint needs to be replaced. Evidence of seepage is visible, but rust in the vicinity of the joint is light.

12th Joint - Expansion. - Located 33 feet from the 11th joint. The cover plate is in poor condition. The plate is split in several pieces and the rivets are loose.

13th Joint - Expansion. - Located 57 feet from the 12th joint. The cover plate has settled so that the transition across the joint is irregular and causes the blades of the snow plows to strike the joint. The joint otherwise is in good condition.

14th Joint - Angle Nosing. - South Abutment at transition block. The nosing is in good condition and no repair work is required.

I. SUITABILITY OF ORIGINAL DESIGN

11. Suitability of Original Design. - The original design was entirely suitable for the intended use. If the bridge were being designed today, it would be desirable to have grades of less than the 6 percent grades of the existing bridge. The existing grades add to the difficulty of winter driving and accentuate the need for sanding and the use of deicing salts. Because of the grades, trucks must down-shift and thus slow the passage of traffic across the bridge. The four existing traffic lanes are each ten feet in width. For present day vehicles, it would be desirable to have wider lanes. The interiors of the existing box girders require additional labor for inspection, surface preparation, and painting. A different type of design could eliminate this feature.

J. ADEQUACY OF EXISTING BRIDGE

12. Adequacy of Existing Bridge. - The bridge is adequate for the volume of present-day vehicular traffic on the basis of traffic counts made available by the Massachusetts Department of Public Works. Traffic is expected to increase when the completion of U.S. Highway 195 and Massachusetts Highways 3 and 25 will permit easier and quicker access to Cape Cod from all of New England as well as the New York area.

K. BASIC DATA AND DESIGN CRITERIA

13. General. - It is essential that this project be designed and constructed in a manner that will cause no interruption or hazard to shipping and keep to an absolute minimum disruptions to vehicular traffic and the economy of the region. This criteria is obligatory in addition to the usual engineering and design requirements for economy in construction and ultimate maintenance costs.

To meet this criteria, construction will be phased so that no construction on the bridge decks will be permitted during the periods of Friday, 12 June through Monday, 14 September of 1964, and Friday, 11 June and Monday, 13 September of 1965. This is necessary because the chief source of income for the inhabitants of Cape Cod is the tourist industry.

To facilitate snow removal and deicing operations and to protect the travelling public, the contractor will be required to suspend operations, remove all materials and equipment, and leave all four lanes of the bridge in a safe, passable condition during the period of Friday, 13 November 1964 through Monday, 1 March of 1965.

The Cape Cod Canal bisects the Township of Bourne, Massachusetts. When the Bourne Highway Bridge is closed, essential service equipment such as fire appartus, police cruisers, school buses, ambulances, and state and town maintenance equipment must be rerouted over the Sagamore Highway Bridge. For this reason, total closures of the Bourne Bridge will be limited to essential periods and during the remainder of the construction operations, one lane of traffic will be permitted in each direction.

14. Safety Requirements. - To facilitate construction and to reduce the inconvenience to the public to a minimum, it is proposed to close the bridge to all traffic on 2 March 1964. Prior to this date, adequate safety, construction, and traffic control signs will be erected in accordance with the requirements of the Massachusetts Department of Public Works.

The contractor will be required to pay for adequate police personnel to direct and control traffic for the protection of the travelling public as well as the contractor's personnel at all times except when the bridge is open to four lanes of traffic.

All pedestrians and all trucks, except trucks of the contractor, with a capacity in excess of one ton will be excluded from the bridge except when the bridge is open to four lanes of traffic. The limitation on trucks is necessary because of the danger involved in the passing of larger trucks in only two of the narrow ten-foot lanes concurrent with construction operations. Larger trucks can cross the Cape Cod Canal by way of the Sagamore Highway Bridge.

All construction operations of the contractor shall be in accordance with EM 385-1-1, dated 13 March 1958. This manual requires employees working over dangerous waters or subject to fall be provided with safety belts and life lines or safety nets.

15. Removal of Bituminous Pavement. - As soon as the bridge is closed, the bituminous concrete will be removed by the heater-planer method to minimize the damage to the top of the light-weight concrete deck. The three existing lane markers will be removed.

16. Repairs to Deck and Membrane Waterproofing. - All necessary repairs to the central 30 feet of the 40-foot roadway deck will be made including the replacement of one half of Bay 6 on Span No. 6. The half-bay area to be replaced is 26 feet long by 20 feet wide.

The central 30 feet of the 40-foot roadway will then be cleaned by sandblasting and compressed air. An epoxy resin-bituminous-membrane type waterproofing will be applied. The waterproofing operation will also include a screed coat of ERB material with a filler load to fill surface holes not exceeding one inch in depth. Holes exceeding one inch in depth will be repaired with epoxy resin bonded portland cement grout prior to the application of the waterproofing. The epoxy resin-bituminous material shall be composed of a base polymer, bituminous material, plasticizer, suitable activator and contain no fillers. The base polymer shall be thermosetting resin of the epoxy type and meet the requirements of applicable paragraphs of the Federal Specification MMM-B-00350, "Binder (Adhesive), Epoxy Resin Base, Flexible". The bituminous material shall meet the applicable requirements of Federal Specification R-P-381 "Pitch, Coal Tar(for) Mineral Surface Built-up Roofing, Waterproofing and Dampproofing". The membrane will be one-ply of a woven glass cloth

weighing not less than 9 ounces per square yard with a 20 mil thickness. The cloth will have all oils, starches, paraffin and other material removed and treated with a volan finish. The waterproofing will be surfaced while still tacky with a 1/8" - 1/4" aggregate to facilitate mechanical bond between waterproofing and bituminous binder coarse.

17. Binder Course. - A dense one-inch binder course will be applied for a width of 35 feet of the 40-foot roadway. The remaining unpaved portion of the deck will be immediately adjacent to one of the curbs. Traffic lane markers will be painted on the binder course. Barricades will then be erected along the center line of the bridge and the bridge reopened on Friday, 1 May 1964 for two lanes of traffic (one in each direction). It is estimated that it will take two months to accomplish this portion of the work. Reopening is dependent upon suitable climatic conditions for placement of the concrete, the bituminous concrete, and the epoxy materials.

18. Demolition of Five-Foot Strip. - Upon the reopening of the bridge on Friday, 1 May 1964, for two lanes of traffic, the contractor will proceed with the demolition of a five-foot wide strip of the roadway deck and adjacent curb on one side of the bridge only.

19. Buckle Plates. - Upon completion of the demolition and preparatory work necessary in any one bay, the contractor shall immediately install a buckle plate of the type shown on Plate Nos. E-2 and E-3. The computations for the buckle plates are given in Plate Nos. B-1 and B-2. The buckle plates were selected as the most expeditious method for rapidity of construction. Buckle plate installation across the entire bridge will proceed as rapidly as possible and replacement of concrete will follow with a minimum time lapse thereafter.

Structural steel used for buckle plates and expansion joint replacement is designed for the working stresses of bridge and building steel with a yield point of 36,000 psi minimum (A36). The design conforms to the latest AASHO specifications and used a basic working stress of 20,000 psi.

Buckle plates will be bolted to the existing bridge steel with hi-strength bolts. Welding will not be called for, since much of the existing steel is silicon steel that would require a special welding procedure. Based on experience in repairing the Sagamore Bridge, it was found that welding was more costly and time consuming than bolting.

The dead load of the bridge after completion of repairs will be approximately 2% greater than the dead load existing in 1938 when an additional 1" of pavement was added to the original dead load. The bridge was investigated at that time for this increase in dead load and was found to have ample capacity for the added weight.

20. Concrete for Deck. - Concrete to be used for replacement of the bridge deck will contain lightweight aggregate conforming to ASTM Standard C330 "Lightweight Aggregates for Structural Concrete". The concrete will be designed for a high quality air-entrained concrete with a minimum compressive strength of 3,000 PSI and a dry unit weight of not more than 100 pounds per cubic foot. An acceptable water reducing admixture conforming to CRD-C87-62 Type A will be incorporated into the concrete mix design to facilitate obtaining the desired density.

21. Concrete for Abutments. - Concrete to be used for replacement on the abutments will contain normal weight aggregate to match the existing concrete and will also be designed for high quality air-entrained concrete with a minimum compressive strength of 3,000 p.s.i.

22. Granite Curbs. - The existing step type of concrete curbs on the bridge will be replaced with type VB17x5 granite curbs, top and bottom sawn.

23. Expansion and Deflection Joints. - As the work progresses, each of the expansion and deflection joints will be rebuilt. This will be accomplished by rebuilding the joints in two halfs. The 20-foot portion from which traffic is excluded will be rebuilt concurrently with the reconstruction of the five-foot wide portion of the deck.

Drain troughs will be provided under the expansion joints to catch salt laden water from the roadway deck. Steel pipe extensions will be attached to these troughs to convey the storm water to the bottom of the lower chords of the trusses.

All exposed surfaces of the expansion joint members, that will be affected by drainage water from the bridge deck will be cleaned by sand blasting to the bare metal. After the surfaces have been acceptably cleaned, they will be painted with coal tar epoxy similar to that used for waterproofing the deck.

24. Scuppers. - The existing scuppers will be replaced with new scuppers designed to fit the buckle plates and equipped with standard pipe size discharges. Pipe extensions will be attached to the scupper

discharges to convey the storm water to the bottom of the lower chords of the trusses.

25. Repairs to Sidewalk. - Minor surface repairs are necessary for the sidewalk. Upon completion of these repairs, the surface will be waterproofed with an epoxy-resin-bituminous-membrane. Sand will be broadcast on the surface of the waterproofing to provide the traction necessary for pedestrian traffic. The two-foot curb on the opposite side of the bridge will be similarly treated when it is reconstructed.

26. Paving Five-Foot Section. - As the five-foot section of slab at the edge of the deck is completed, it will receive waterproof membrane lapped to the waterproofing of the central portion of the bridge. After the installation of the granite curbs, the deck will then receive a one-inch layer of dense binder to match the central portion of the bridge.

27. Transferal to Opposite Side of Bridge. - With this work completed, the two lanes of vehicular traffic will be transferred to the completed side of the bridge. Work will then start on the opposite side of the bridge.

28. Final Bituminous Paving. - When the opposite side is completed, the entire roadway will be given a dense one-inch bituminous concrete wearing course topped with an abrasive non-skid seal coat to provide the necessary traction. It will be necessary to close the bridge for two weeks to accomplish the final paving. With the completion of this work, the bridge will be reopened to four lanes of traffic.

29. Catwalk and Ladders. - In addition to the work on the deck and abutments, the catwalk under the bridge will be repaired. Portions of the catwalk grating and railings will be replaced. The access ladders will be equipped with cages and platforms, or approved safety ladder devices designed to fit the specific conditions.

30. Painting. - All exposed surfaces of the bridge deck stringers, beams, bracing, walkway and deck railings, will be painted. After cleaning all bare metal surfaces, except at expansion joints, the steel will be painted with one coat of red-lead paint and two coats of aluminum paint. All cleaned surfaces exposing the existing coat of red-lead or

zinc-chromate primer will be painted with two coats of aluminum paint. All cleaned surfaces on which the primer is not exposed will be painted with one coat of aluminum paint. See paragraph No. 23 for the treatment of the expansion joints.

31. Minor Concrete Repairs. - Minor concrete repairs will be required on the piers and portions of the abutments in addition to the repairs on the abutment decks.

32. Existing Electrical Circuits. - Electrical circuits on the bridge consist of (a) series lighting for the south bank of the Cape Cod Canal, 616 feet of multiconductor cable being supported along the catwalk below the road surface of Span No. 1 only, (b) series lighting for the bridge, 5,468 feet of single conductor cable run in one of two fiber ducts extending from end to end along each side of the bridge, within the concrete curb on the east side and within the sidewalk on the west side, including 30 rectangular steel handholes with covers, one at each bridge light location for enclosure of transformers, and (c) navigation lighting for marking the channel and obstruction lighting at the highest point of the bridge, 1,161 feet of multiconductor cable run in the second of the above mentioned two fiber ducts under the walk along the west side, from the north pylon to the center of the bridge.

33. Existing Communication Circuits. - Communication circuits on the bridge consist of (d) three New England Telephone and Telegraph Company multiconductor cables run in the 3 lower ducts of a bank of six wooden ducts extending from pylon to pylon along the west side of the bridge under the sidewalk, including 8 structural steel manholes with covers in the sidewalk, and (e) 616 feet of Government multiconductor cable for intercommunication between the Bourne and Sandwich Offices, supported along the catwalk below the road surface of Span No. 1 only.

34. New Electrical Work. - A third duct will be added between the center of Span No. 1 and the north pylon. This will permit running a 120 volt receptacle circuit in one of the two ducts along the entire length of each side of the bridge. Since demolition of the curb on the east side is required, the 3rd duct, 1,161 feet in length, will be incorporated in the rebuilt granite faced concrete curb section and duct line between the center of Span No. 1 and the north pylon. Circuit (c) above, will be changed from the west side to the east side. In all, 1,223 feet of new 2E duct and 1,161 feet of new 3E duct will be installed, 11 new rectangular steel hand holes with covers will be installed, approximately 5,600 feet of new single conductor bridge lighting

cable (circuit b) and approximately 1,300 feet of new three conductor navigation and obstruction lighting cable (circuit c) will be installed.

Existing electrical handholes will have any missing or corroded covers or cover screws replaced and new neoprene gaskets will be furnished for all electrical handholes. Lighting transformers in 15 west side and 4 east side handholes will be reconnected to the new series lighting cable, those in 11 east side handholes will be removed, reinstalled in the new handholes and reconnected to the new series lighting cable.

No interruption to canal lighting, navigation and obstruction lighting can be tolerated and one half of the bridge lighting must be kept in operation during the construction period. Temporary construction power, highway barricade lighting, etc. may be obtained by the contractor from Plymouth County Electric Company in the vicinity of the north pylon and from Cape & Vineyard Electric Company in the vicinity of the south pylon.

Communication cables (d) and (e) will not be disturbed. The sidewalk along the west side of the bridge will be overlaid with a waterproof membrane topped with sand. In connection with this work, New England Telephone and Telegraph Company will be required to revise their 8 manholes so that covers will match the new sidewalk grades.

L. GAS LINE RELOCATION

35. Gas Line Relocation. - The Buzzards Bay Gas Company with offices at Hyannis, Massachusetts had two gas lines on the Bourne Highway Bridge by right of sufferance. In anticipation of the major rehabilitation of the bridge, NED requested the gas company to remove the 8-inch gas line which was located on the east curb of the bridge deck. This work was completed in the spring of 1963 at no cost to the Government.

The relocation was accomplished by first removing the 6-inch gas line from under the bridge deck and replacing it with a 10-inch gas line.

The new 10-inch gas line was installed in the existing 12-inch diameter holes in the built-up girders. This existing hole is located two inches west of the center line of the bridge and three feet from the bottom cover plates of the girders.

The 8-inch gas line was then removed from the east curb of the bridge deck. The new 10-inch line will be the only gas line located on the bridge inasmuch as it replaces both the 6-inch and the 8-inch gas lines which were removed.

This work was accomplished under Easement No. DA-19-016-CIVENG-63-195, as approved by the Secretary of the Army.

M. CONDENSED CONSTRUCTION SCHEDULE

36. Condensed Construction Schedule. -

Date	Traffic Control	Work to be Accomplished
Monday, 20 Jan 64	None	Award Contract. Submit Shop Drawings for approval. Deliver material to site.
	Spring, 1964	
Monday, 2 Mar 64	Bridge completely closed	Begin Phase A. (central and west side) Remove Bit. paving. Remove lane markers. Repair central 30 Ft. of roadway deck. Replace 1/2 Bay in Span 6. Apply waterproofing 30 ft. wide. Apply binder course 35 ft. wide.
Friday, 1 May 64	2 lanes open	Demolish 5-ft. strip of deck and curb on west side. Install buckle plates. Place lightweight concrete. Install & lap deck waterproofing. Install curbs. Place binder course. Repair sidewalk and apply membrane waterproofing topped with sand coat. All equip. and materials to be removed from deck.
	Summer, 1964	
Friday 12 Jun 64	4 lanes open	Install cages, platforms, and safety devices on ladders. Repair catwalk. Painting. No work to be allowed on deck.

36. Condensed Construction Schedule (Cont'd.)

Date	Traffic Control	Work to be Accomplished
	Autumn, 1964	
Monday, 14 Sep 64	2 lanes open	Continue and complete work described above for the period 1 May thru 12 Jun 64. All equip. & materials to be removed from bridge. End Phase A.
	Winter, 1964-65	
Friday, 13 Nov 64	4 lanes open	No work to be performed during winter months.
	Spring, 1965	
Monday, 1 Mar 65	2 lanes open	Begin Phase B(East side and Central) Install temporary wiring for lighting and communications. Remove existing wiring & devices. Remove 5 ft strip of binder. Demolish 5 ft strip of deck and curb on east side. Install buckle plates. Place lightweight concrete. Install & lap waterproofing. Install curbs. Place binder course. All equip. & materials to be removed from deck.
	Summer, 1965	
Friday, 11 Jun 65	4 lanes open	Finish installation of cages, platforms and safety devices on ladders. Finish repairs to catwalk. Painting. No work to be allowed on deck.
	Autumn, 1965	
Monday, 13 Sep 65	2 lanes open	Continue & complete work described above for the period 1 Mar thru 11 Jun 65. Install new wiring & devices for lighting & communication. Remove temporary wiring. Painting.

36. Condensed Construction Schedule (Cont'd.)

Date	Traffic Control	Work to be Accomplished
Monday, 18 Oct 65	Bridge completely closed	Place 1 in. bit. wearing course. Apply membrane waterproofing to east curb topped with sand coat. Apply abrasive non-skid seal coat. Paint lane markers. Paint railings. All equip. & materials to be removed from deck.
Friday, 29 Oct 65	4 lanes open	Complete painting. Remove all equip., surplus materials, & debris from site. Clean up. End Phase B.
Friday, 12 Nov 65	4 lanes open	Demobilization. Project complete.

N. COMPARISON OF PROPOSED DESIGN WITH ORIGINAL DESIGN

37. Membrane Waterproofing. - The impervious membrane waterproofing will arrest the deterioration of the bridge deck by excluding moisture and sodium and calcium chloride in solution. At the time of the original design, all materials available for waterproofing were porous and incapable of providing the necessary protection.

38. Granite Curbs. - The granite curbing to be specified is impervious to alternate thawing and freezing, to the attack of deicing salts and the impact and abrasion of snow removal equipment. The existing light-weight concrete curbs are vulnerable to all of these destructive forces and require annual patching and repair by hired labor.

39. Expansion Joints. - All of the expansion joints are to be rebuilt. Insofar as possible, supporting members of the expansion joints which were not readily accessable for painting will be encased in concrete. The existing 1-1/8-inch sliding cover plates were frequently dislodged by snow removal equipment and the impact of concentrated wheel loads. As a consequence, these plates have been an incessant maintenance problem and have required repeated

repairs by hired labor. These cover plates are to be replaced with interlocking toothed plates designed to eliminate this maintenance problem. The two existing expansion joint cover plates 3 inch by 6 feet will be retained because they function satisfactorily and have not been the cause of maintenance problems.

40. Bituminous Concrete Paving. - The bituminous concrete paving will be designed with a lean dense mix. This is necessary to resist the effects of concentrated wheel loads and the resultant creep in the pavement wearing surface. The existing bituminous paving is adequate for highway use, but lacks the density necessary for the six percent grades of the bridge. The abrasive non-skid seal coat is necessary to provide traction during rainy or freezing weather.

O. NECESSITY FOR REPAIRS

41. Necessity for Repairs. - The Bourne Highway Bridge is a vital and essential link in the economy of Cape Cod. It is also vital to the national defense inasmuch as it is a means of access to Otis Air Force Base and other defense installations located on the Cape. If the Bourne Highway Bridge were closed permanently for the lack of necessary repairs, the Sagamore Highway Bridge of itself would be incapable of carrying the total vehicular traffic during the months of July and August. The Corps of Engineers is obligated to maintain this bridge in accordance with its authority to construct and maintain the Cape Cod Canal.

P. COST ESTIMATE

42. Cost Estimate. - The following cost estimate is based on 1963 price levels.

CAPE COD CANAL

BOURNE HIGHWAY BRIDGE - MAJOR REHABILITATION

COST ESTIMATE

Item No.	Description	Phase A (Central & West Side) Quantity	U.P.	Amount	Phase B (Central & East Side) Quantity	U.P.	Amount
1	Traffic Signs, Install & Remove	1 Job	L.S.	$ 5,000	1 Job	L.S.	$ 2,300
2	Temporary Electric Lines				1 Job	L.S.	3,500
3	Traffic Control Police	8,200 Hrs.	$ 3.20	26,240	12,200 Hrs.	$ 3.20	39,040
4	Existing Bituminous Pavement, Remove	11,940 SY	1.30	15,522			
5	Transition Section at Abutment, Grout Under & Repair	2 Ea.	2,500.00	5,000			
6	Existing Bridge Deck, Repair	7,000 SF	3.40	23,800			
7	Existing Bridge Deck, Waterproof	9,300 SY	7.50	69,750			
8	Existing Bridge Deck, Bit. Prime Coat	3,200 Gals.	.50	1,600			
9	Existing Bridge Deck, Bit. Concrete Binder Course	10,620 SY	1.30	13,806			
10	Bridge, Remove Temporary Bit. Concrete				1,325 SY	1.60	2,120
11	Bridge, Remove Curbing	2,384 LF	14.00	33,376	2,384 LF	14.00	33,376
12	Bridge, Remove Deck	1,370 SY	30.00	41,100	1,325 SY	30.00	39,750
13	Abutment, Remove Curbing	300 LF	6.75	2,025	300 LF	6.75	2,025
14	Bridge, Remove 1/2 Expansion Joint	8 Ea.	920.00	7,360	8 Ea.	920.00	7,360
15	Abutment, Remove 1/2 Expansion Joint	4 Ea.	250.00	1,000	4 Ea.	250.00	1,000
16	Bridge, Remove & Replace 1/2 Flange Cover Plate	3,700 Lbs.	1.10	4,070	3,700 Lbs.	1.10	4,070
17	Bridge, Repairs to Existing Steel	15,300 Lbs.	.70	10,710	11,900 Lbs.	.70	8,330
18	Bridge, New Expansion Joints (1/2)	8 Ea.	3,000.00	24,000	8 Ea.	2,500.00	20,000
19	Abutment, New Expansion Joints (1/2)	4 Ea.	750.00	3,000	4 Ea.	700.00	2,800
20	Bridge, Buckle Plates	225,000 Lbs.	.23	51,750	208,000 Lbs.	.23	47,840
21	Bridge, New Concrete Bridge Deck	1,370 SY	18.00	24,660	1,325 SY	18.00	23,850
22	Existing Bridge Deck, Repair Underside of Concrete	300 SF	30.00	9,000			
23	Electric Ducts, Handholes & Cables				1 Job	L.S.	18,000
24	Bridge, Granite Curbing	2,320 LF	13.00	30,160	2,300 LF	15.00	34,500
25	Bridge, Granite Curb at Handholes				66 LF	16.50	1,089
26	Abutment, Granite Curbing	276 LF	9.50	2,622	276 LF	9.50	2,622
27	Abutment, Granite Curb at Handholes				24 LF	11.00	264
28	Sidewalk, Repair Surface	100 SF	1.95	195			
29	Sidewalk, Surface Treatment	1,850 SY	7.00	12,950			
30	Abutment, Repair Top of Curb				450 SF	3.00	1,350
31	Bridge, Waterproof	1,325 SY	7.00	9,275	1,325 SY	7.00	9,275
32	Bridge, Prime Coat for New Deck	400 Gals.	.75	300	400 Gals.	.75	300
33	Bridge, Bit. Concrete Binder Course for New Deck	1,325 SY	1.40	1,855	1,325 SY	1.40	1,855
34	Catwalk, Extension and Repairs	1 Job	L.S.	47,000			
35	Ladder, Safety Cages & Platforms	1 Job	L.S.	17,000			
36	Scupper Extensions	1 Job	L.S.	12,500	1 Job	L.S.	12,500
37	Bridge & Abutments, Bituminous Tack Coat				1,500 Gals.	.40	600
38	Bridge & Abutments, Bit. Concrete Surface Course				11,940 SY	1.00	11,940
39	Bridge & Abutments, Bituminous Seal Coat				1,840 Gals.	.30	552
40	Bridge & Abutments, Aggregate for Seal Coat				60 CY	15.40	924
41	Painting	1 Job	L.S.	24,000	1 Job	L.S.	40,200
				$530,626			$373,332

TOTAL, PHASES A & B: $903,958

ADOPT: $904,000

CAPE COD CANAL

BOURNE HIGHWAY BRIDGE

MAJOR REHABILITATION

COST ESTIMATE -- SUMMARY

Major Rehabilitation

Construction Cost	$ 904,000
Contingencies	181,000
Sub-Total - Basic Construction Cost	$1,085,000
Engineering and Design	60,000
Supervision and Administration	85,000
TOTAL PROJECT COST:	$1,230,000

Q. RECOMMENDATIONS

43. Recommendations. - It is recommended that the project plan submitted in this report be approved as the basis for the preparation of contract plans for the Bourne Highway Bridge - Major Rehabilitation Project.

RESULTS OF COMPRESSIVE STRENGTH TESTS ON 2X2 - INCH CUBES OBTAINED FROM 6-INCH DIAMETER CORES

Tested by: NED Laboratory
Tested on: 5 June 1963

Laboratory Serial No.	Core No.	Compressive Strength (PSI) Top of Core	Bottom of Core	Average
71-53-1	A	10,000	14,000	12,000
71-53-3	C	7,760	6,860	7,310
71-53-4	D	8,810	5,000	6,905
71-53-6	F	4,500	3,450	3,975
71-53-7	G	5,050	4,400	4,725
71-53-8	H	2,160	1,170	1,445
71-53-11	K	6,370	8,200	7,285
71-53-12	L	8,880	9,760	9,320
71-53-13	M	7,130	-	7,130
71-53-14	N	3,450	3,410	3,430
71-53-15	O	5,740	-	5,740
	AVERAGE	6,350	6,250	6,305

NOTES: 1. For location of cores see Condition Survey Plates Nos. D-1 thru D-10.

2. Cubes were sawed, where possible, from top and bottom of cores. It was impossible due to location of steel or size to obtain cubes from cores nos. B, E, I, and J and only one cube from cores M and O.

PLATE NO. A-1

Werby LABORATORIES • INC.
Consulting and Analytical Chemists
88 Broad Street • Boston 10 • Massachusetts • Liberty 2-0739

June 10, 1963

Samples of : CONCRETE - 4

Marked : Confirming Telephoned Report Previously Rendered

Submitted by : U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Mass.

Purchase Order No. NEDSP-63-1323

Laboratory Serial Nos. 71-53-2 Top & Bottom; and
71-53-11 Top & Bottom

The samples submitted have been among the most difficult to handle satisfactorilly that the writer has experienced. When first received, apparantly too much vigor was used to scrape off suspected material from the four specimens submitted with the result that analyses showed a wide range of elements normally present in the matrix itself.

Subsequent attempts at washing the "salt" material off were not fruitful, the "salt" being insoluble.

Finally, scrapings with a blunt micro-spatula were made of all samples, being extremely careful not to go into the concrete itself. From these specimens, it was concluded that the "salt" observed was essentially calcium, although it was not possible to establish what form exactly the calcium was in. It does not appear to be chloride, sulfate, or carbonate. It is thought that it may be in the form of a complex oxide. An exact identification could be made perhaps by x-ray diffraction study if necessary.

Of course, due to the limitations discussed above, quantitative data could not be established; except that 71-53-11 TOP exhibited the greatest amount of "salt", with 71-53-2 TOP the next highest amount, 71-53-11 BOTTOM showing a slight amount, while 71-53-2 BOTTOM showed nothing of this type that could be detected.

WERBY LABORATORIES, Inc.

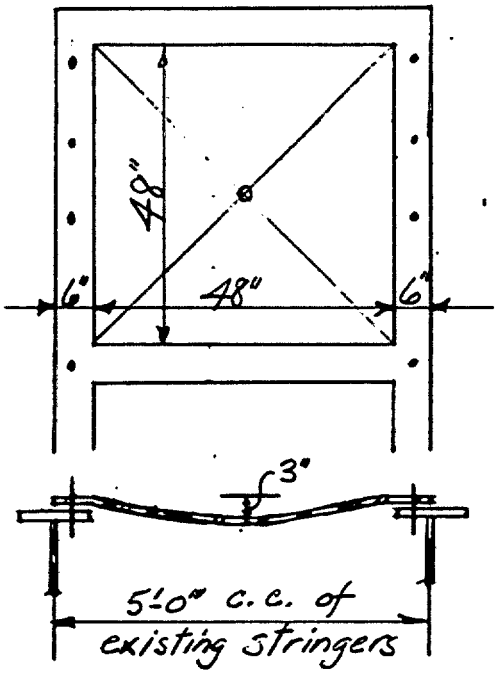
Russell T. Werby, Manager

PLATE NO. A-2

SUBJECT Cape Cod Bourne Bridge
COMPUTATION Design of New Buckle Plates
COMPUTED BY GER. CHECKED BY DATE 10/17/63

New Buckle Pls

A 36 Steel



Span = 5'-0" C.C. of stringers

New slab of lightweight conc. @ 100 #/Δ' to be 6½" ± above top of stringers.

"Winkler" formula for buckle pl loads taken from 1934 Carnegie Pocket Companion, pg. 374

2" Bit. conc = 25
7¾" slab @ 100 = 64
5/16" Pl = 13
102. #/□ = .70 #/□"

$$P = \frac{t(100fdt - 25.2wab)}{6d + 15t}$$

$t = .31"$ $w = .70$ #/□" $f = 20{,}000$ #/□"
$d = 3"$ $a \times b = 48"$

$$P = \frac{.31\left[(100 \times 20000 \times 3 \times .31) - (25.2 \times .70 \times 48 \times 48)\right]}{6 \times 3 + 15 \times .31}$$

$$P = \frac{.31 \times (1{,}880{,}000 - 41{,}000)}{22.7} = 25{,}300.\#$$ allow. concentrated load per buckle.

Max. H20 S16 wheel load = 16000 × 1.3 impact = 20,800.#

Allow. uniform load = $4fdt = 4 \times 20000 \times 3 \times .31 = 75{,}000.\#$

Per buckle = $\frac{75000}{4 \times 4} = 4700.$ #/□'

∴ Use 5/16" Buckle Pls. ←

PLATE NO. B-1

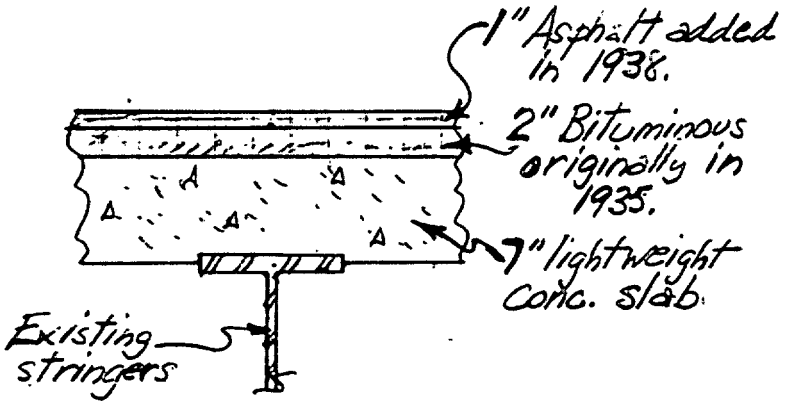
SUBJECT Cape Cod Bourne Bridge
COMPUTATION Comparison of Slab Weights
COMPUTED BY GER. CHECKED BY DATE 10/17/63

Comparison of slab weights

Deck concrete originally lightweight @ 100.#/Δ' dry.

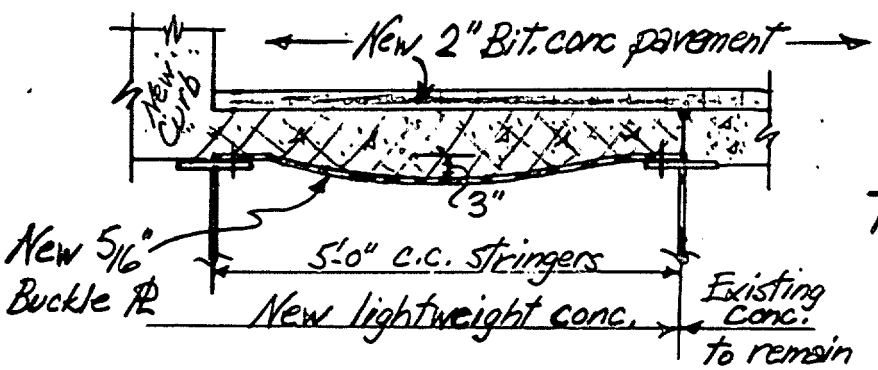
∴ All new deck conc. to be 100.#/Δ' dry.

Existing Deck



3" Bitum @ 150 = 38.
7" slab @ 100 = 58.
96.#/□'

New conc. Deck



2" Bitum. @ 150 = 25.
7 3/4" avg. slab @ 100 = 64.
5/16" Pl = 13.
102.#/□'

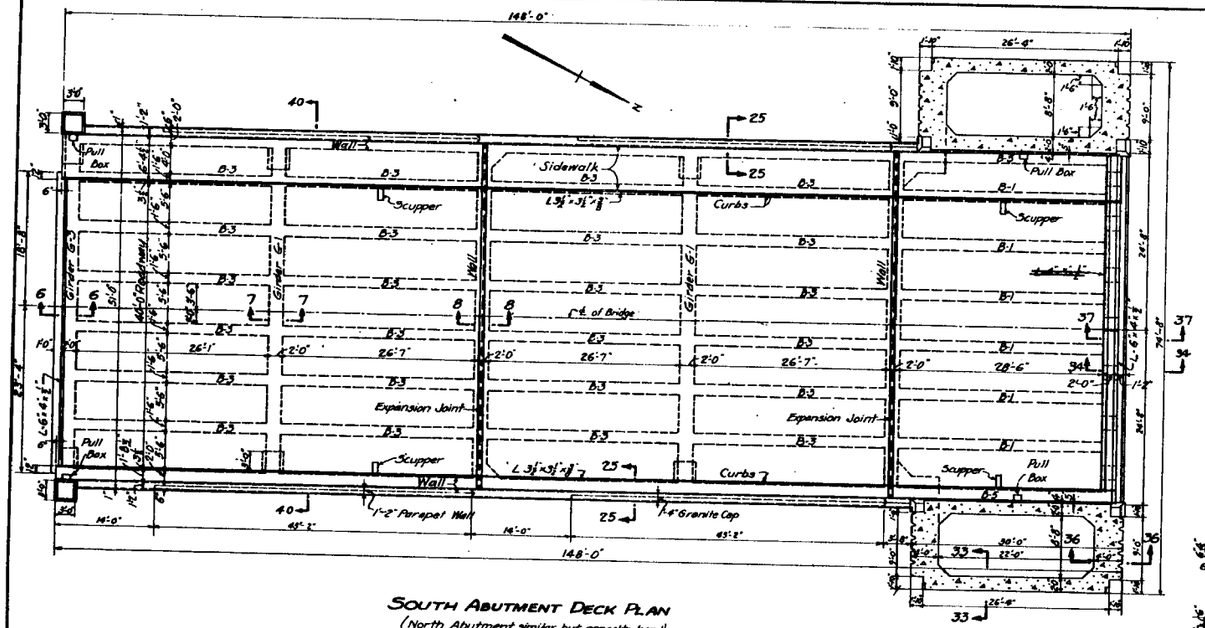
Conc. Depth over buckle Pl

6 1/2" ± above top of stringers
- 1/4 Buckle Pl

6 1/4" + 1 1/2" (avg. of Pl depth.)
= 7 3/4" average depth over buckle Pl.

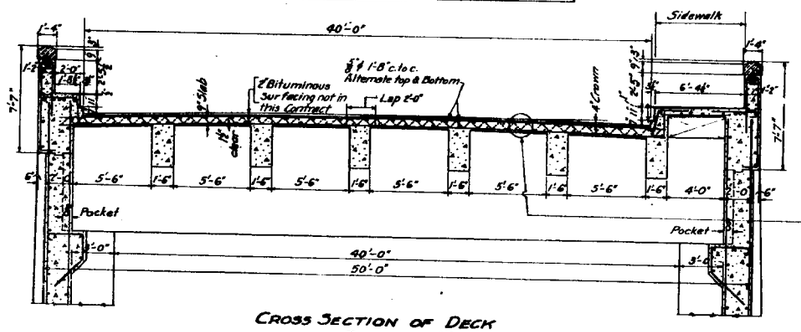
New work will weigh 6#/□' more than existing. However this is only for a narrow 5' band on each side and the total increase in dead load across the 40' road way is only 2%.

PLATE NO. B-2

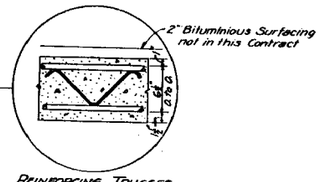


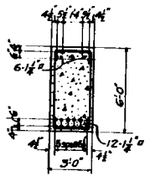
SOUTH ABUTMENT DECK PLAN
(North Abutment similar but opposite hand)

SCALE
0 4 8 16 24 32

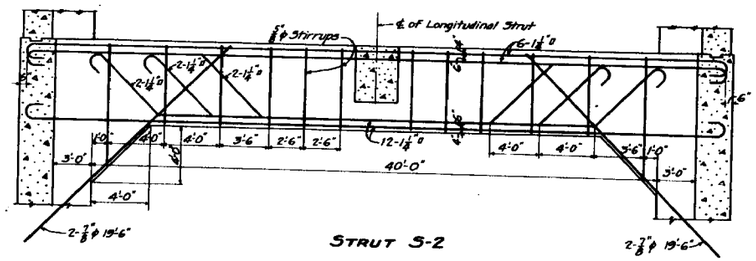


CROSS SECTION OF DECK
SECTION 40-40

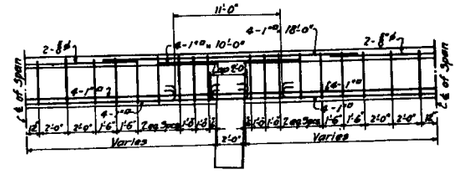




SECTION THRU S-2

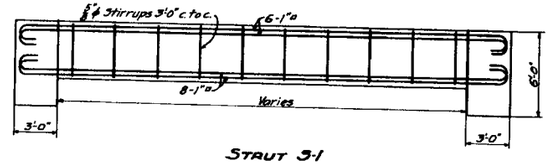


STRUT S-2

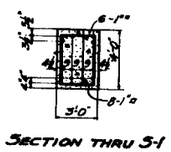


BEAM B-3

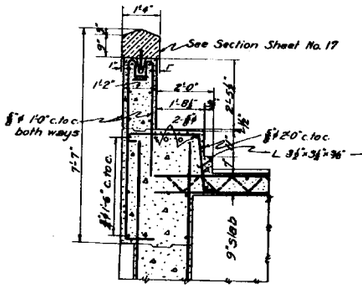
SECTION THRU B-3

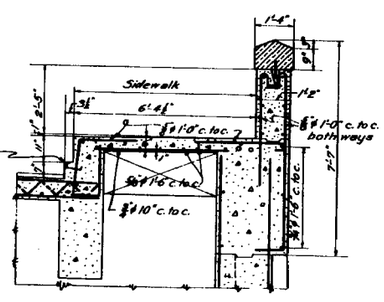


STRUT S-1

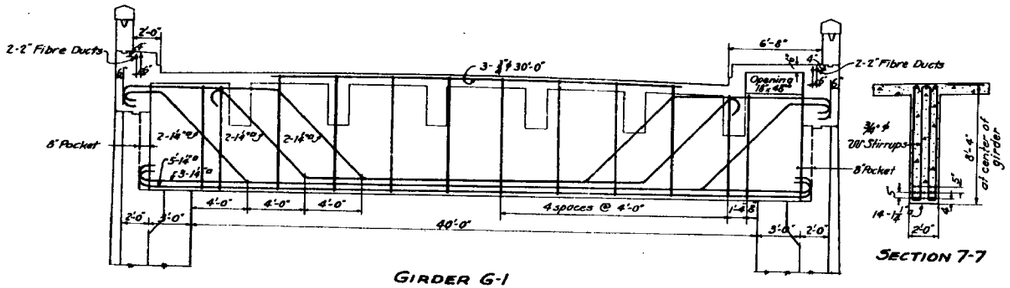


SECTION THRU S-1





DETAIL OF PARAPET AND SIDEWALK
Scale ½"=1'-0"



GIRDER G-1
(For Girder G-3 see Section 6-6 Sheet No. 17
For Girder G-2 see Section 9-9 Sheet No. 17)

SECTION 7-7

Legend
Concrete in Section shown thus:
Reinforcing Steel shown thus:

Notes:
For Sections G-6, 8-8, 25-25, 37-37 see Sheet No. 17
For Sections 33-33, 34-34, 36-36 see Sheet No. 15
For Beam B-1 see Sheet No. 12
For Beam B-3 see Sheet No. 15

FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY Fabian H. Fay

FAY, SPOFFORD & THORNDIKE
BOSTON, MASSACHUSETTS
DESIGNED BY L.B.T.
DRAWN BY H.E.K.
TRACED BY T.V.A. W.H.P.
CHECKED BY M.E.P. H.H.M.
SCALE 1"=1" EXCEPT AS SHOWN

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON MASS.

HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS

BOURNE BRIDGE
ABUTMENT DECK PLANS AND DETAILS

SCALE EXCEPT AS SHOWN
4 0 4 8 12 16FT

APPROVED R. Park
LT. COL. CORPS OF ENGINEERS
OCTOBER 1933

SUBSTRUCTURE CONTRACT PLANS - SHEET No. 16 OF 19

PLATE NO. C-1

REINFORCING TRUSSES
Spaced 6" c. to c. Depth 5" out to out of truss and cambered as shown. Top and bottom chord-area each chord = 0.44 sq. in. web area to average ¼" per lin. ft. of truss

SECTION A-A

CROSS SECTION OF ROADWAY - SPAN 1
(Except as noted)

CROSS SECTION OF ROADWAY - SPANS 4 & 7 AS SHOWN - SPANS 1,2,3,5 & 6 AS NOTED

SECTION SPANS 2 & 3

SECTION SPAN 6

SECTION B-B

SECTION C-C

SECTION E-E

DETAIL OF TRAFFIC MARKER

DETAIL OF CHANNEL CONNECTION TO FLOOR BEAM

DETAIL OF PULL BOX

DETAIL OF WALKWAY (included for payment with structural steel)

FENCE DETAILS

DETAIL AT INTERMEDIATE FENCE POST

ELEVATION INTERMEDIATE FENCE POST

TYPICAL DETAIL AT HANGER

SPACING SCHEDULE FENCE POSTS

Span	No. of Spaces per Panel	Distance Between Posts c. to c.
7	4	7'-6"
5	5	6'-9"
3	6	7'-4"
1	6	7'-4"
2	6	7'-4"
4	4	7'-6"
6	4	6'-6"

Legend:
Concrete in Section shown thus:
Reinforcing steel in section shown thus:
Reinforcing Truss web shown thus:

Notes:
For Spans 1, 2 and 3 see Sheets No. 6-11 inclusive.
For Spans 4, 5, 6 and 7 see Sheets No. 12-15 inclusive.
For details of expansion joints see Sheet No. 5
Bottom of concrete slab to be flush with bottom of top flange of stringers.
All steel to be Carbon unless otherwise noted.
For detail of scuppers see Sheet No. 5
For detail of Lamp post see Sheet No. 10
Rivets to be ⅞" ϕ - Open holes to be 15/16" ϕ
For Section D-D see Sheet No. 5
All fence posts to be vertical.

FAY, SPOFFORD & THORNDIKE, ENGINEERS
BY Columbus M. Spofford

CRAM & FERGUSON, CONSULTING ARCHITECTS
BY E. Cabot Frey

FAY, SPOFFORD & THORNDIKE
BOSTON, MASSACHUSETTS
DESIGNED BY H.G.S.
DRAWN BY H.G.S.
TRACED BY J.T.
CHECKED BY W.L.C.
SCALE 1"-2'-0" EXCEPT AS SHOWN

WAR DEPARTMENT
CORPS OF ENGINEERS U. S. ARMY
OFFICE OF DISTRICT ENGINEER, BOSTON, MASS.

HIGHWAY BRIDGES
OVER CAPE COD CANAL
AT BOURNE, MASSACHUSETTS

SAGAMORE AND BOURNE BRIDGES
DECK SECTIONS
SCALE EXCEPT AS SHOWN

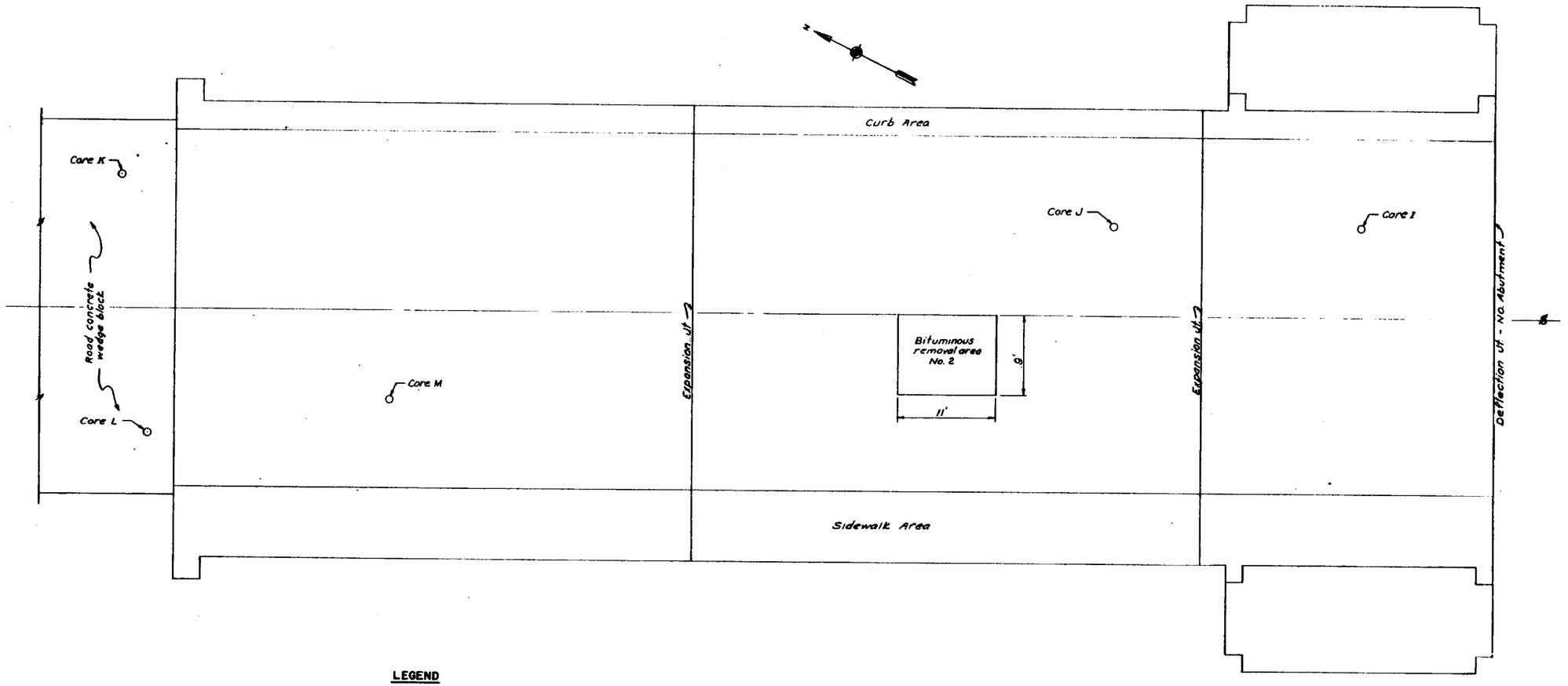
APPROVED
LT. COL. CORPS OF ENGINEERS
DECEMBER 1933

SUPERSTRUCTURE CONTRACT PLANS SHEET No. 4 OF (17)

FILE PLATE NO. C-2

CORPS OF ENGINEERS

U. S. ARMY



LEGEND

- Heavy lines indicate areas that exhibit heavy rusting of structural steel
- Light lines indicate the visual extent of staining due to leakage
- Slash lines indicate heavy flaking of concrete and exposure of reinforcing steel
- 2 — Numerical designation within an area indicates the depth of spalling in inches of concrete in this area
- Bituminous removal areas indicate the location and extent of bituminous surface removal for exploratory purposes
- Location of 4 inch cores removed for exploratory purposes
- Location of 6 inch cores removed for exploratory purposes
- Lines indicate the location and visual extent of cracking accentuated by leakage

GENERAL NOTES

1. Condition survey performed on underside of bridge deck.
2. Cores and bituminous pavement removed from the deck surface.

GRAPHIC SCALE

SCALE 1"=5' 5' 0 5' 10'

CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

NORTH ABUTMENT

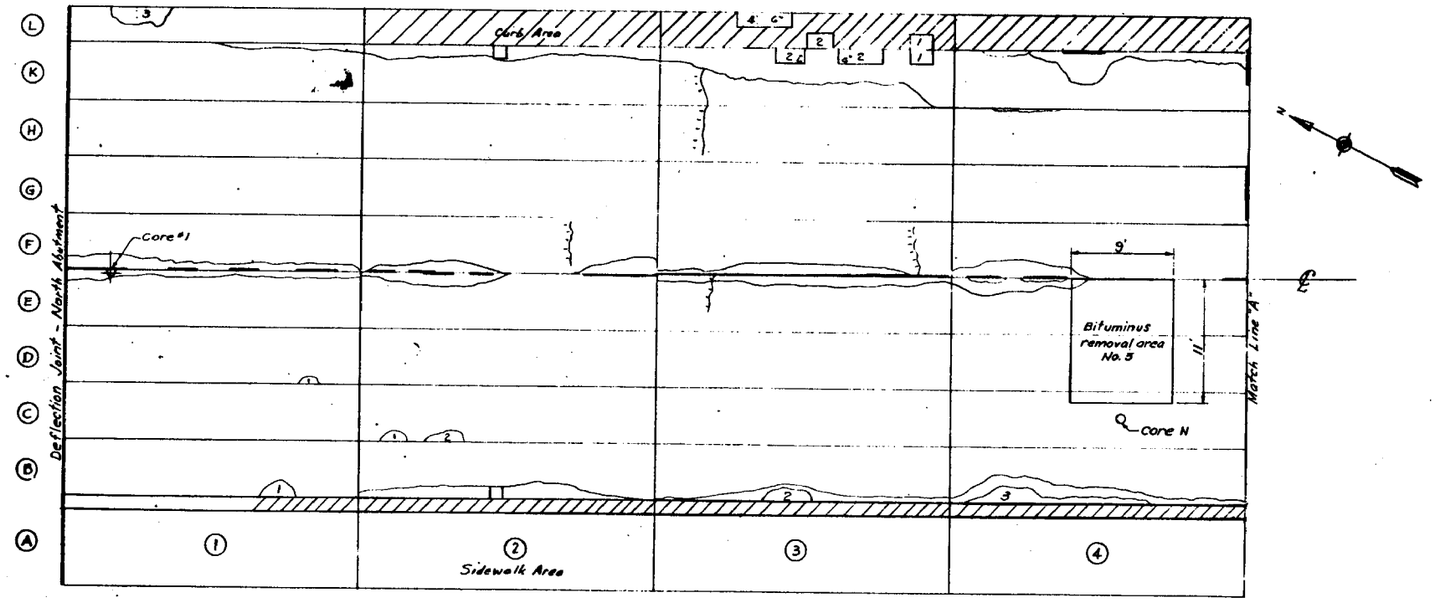
1962—1963

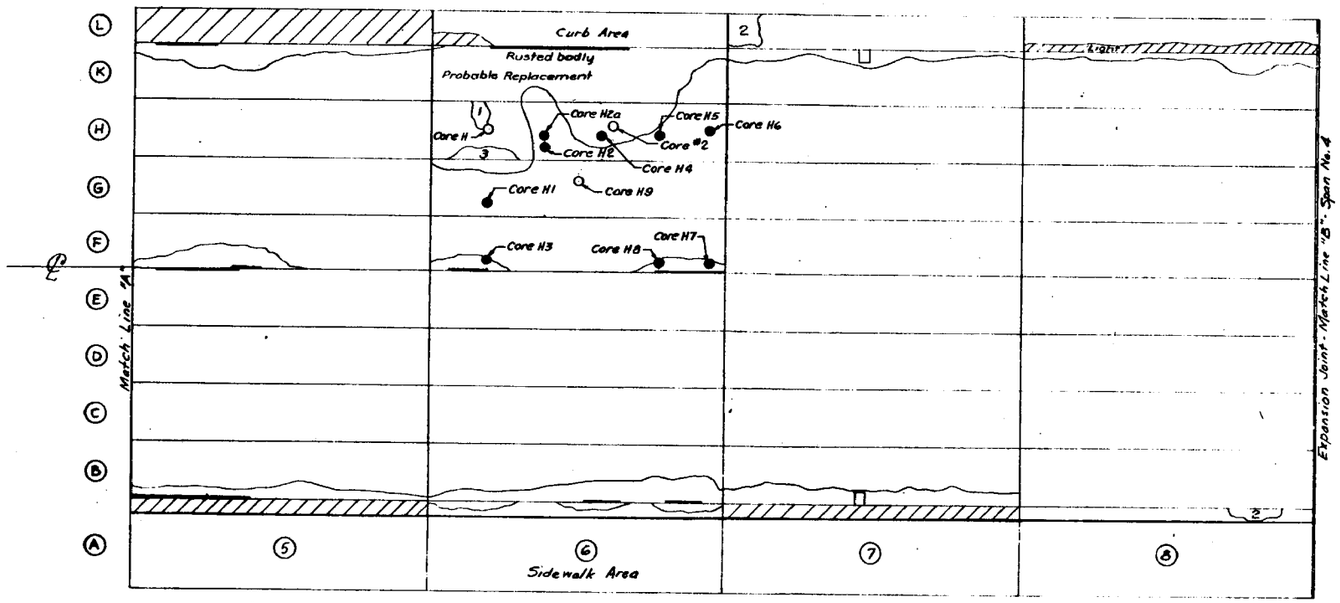
PERFORMED BY

JOSEPH A. McELROY CHIEF CONCRETE SECTION

WILLIAM PALMER, MACHINIST

PLATE NO. D-1





GRAPHIC SCALE
SCALE 1"=5' 5' 0 5' 10'

No A | 4 | 2 | IN | 15 | 3 | 5 | 7 | So. A

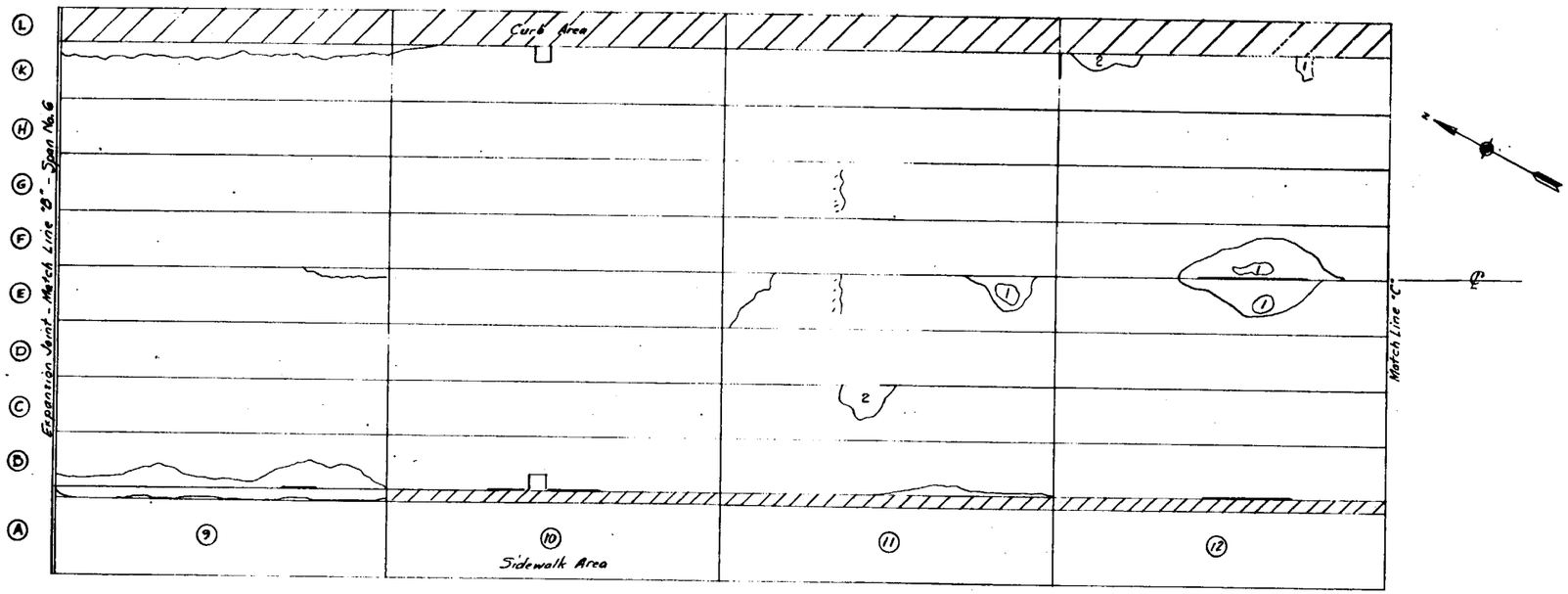
CAPE COD CANAL
BOURNE, MASSACHUSETTS
CONDITION SURVEY
BOURNE HIGHWAY BRIDGE
SPAN NO.6
1962–1963

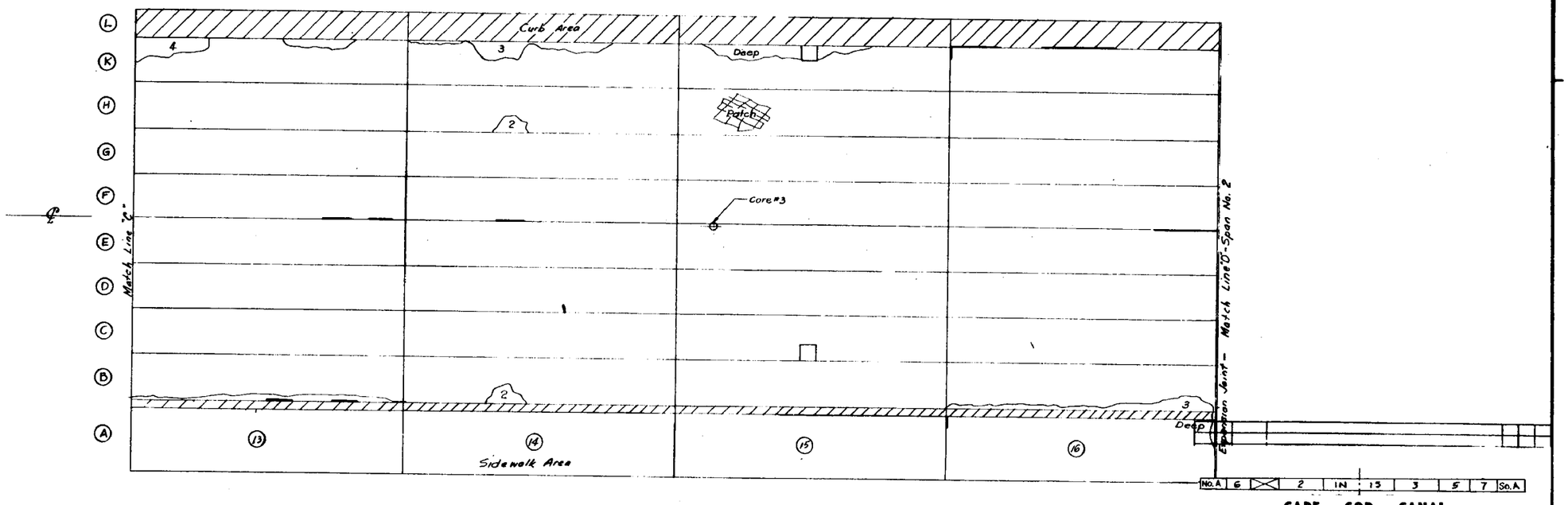
PERFORMED BY
JOSEPH A. McELROY CHIEF CONCRETE SECTION
WILLIAM PALMER, MACHINIST

PLATE NO. D-2

CORPS OF ENGINEERS

U. S. ARMY





CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO. 4

1962—1963

GRAPHIC SCALE

SCALE 1"=5' 5' 0 5' 10'

PERFORMED BY

JOSEPH A. McELROY CHIEF CONCRETE SECTION

WILLIAM PALMER, MACHINIST

PLATE NO. D-3

Expansion Joint - Match Line "O" - Span No. 4

Curb Area

Core G

Honeycomb

Map Cracking

Core # 4

Core # 4A

Core #5
Core # 5A next to it
To get recovery
of concrete

Match Line "B"

Sidewalk Area

3'Deep

3'Deep

Curb Area

Match Line "2" - Span No. 3 (North)

Sidewalk Area

No. A | 6 | 4 | IN | 15 | 3 | 5 | 7 | So. A

CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO. 2

1962–1963

GRAPHIC SCALE

SCALE 1"=5' 5' 0 5' 10'

PERFORMED BY

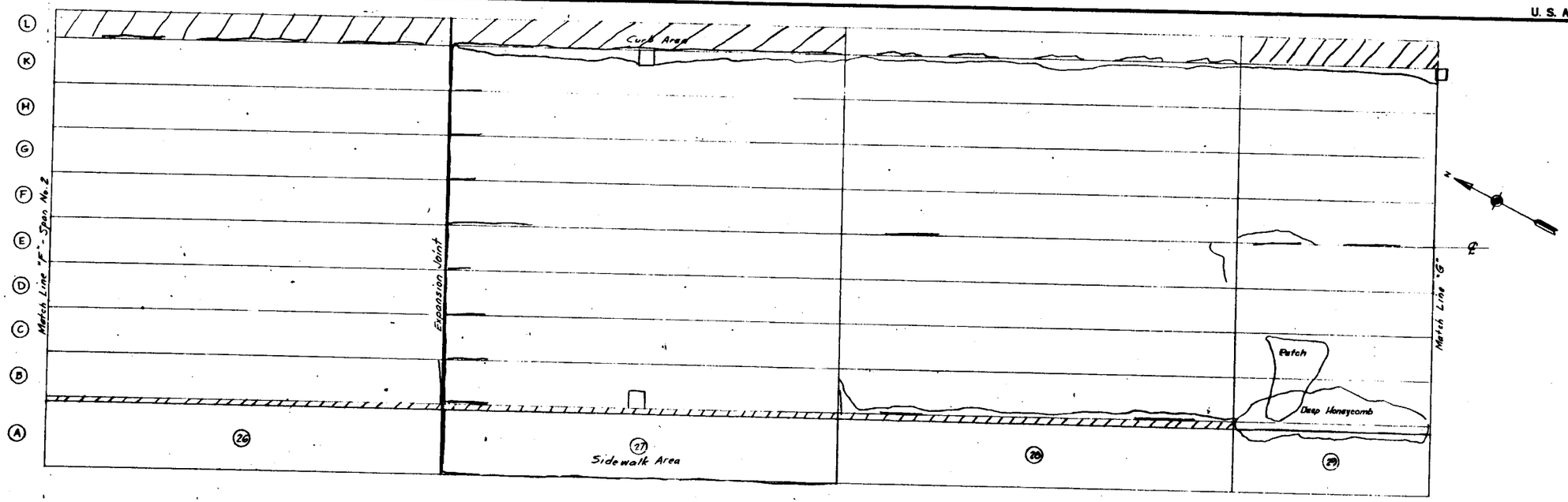
JOSEPH A. McELROY CHIEF CONCRETE SECTION

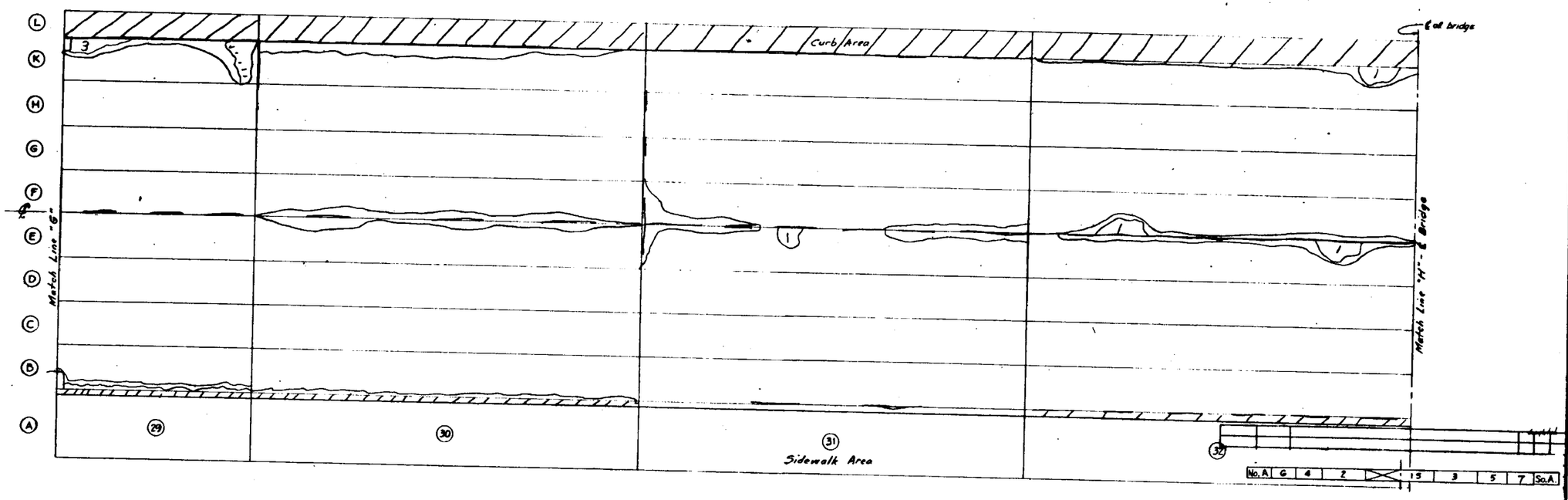
WILLIAM PALMER, MACHINIST

PLATE NO. D-4

CORPS OF ENGINEERS

U. S. ARMY





CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO. 1-NORTH

1962—1963

GRAPHIC SCALE

SCALE 1"=5'

PERFORMED BY

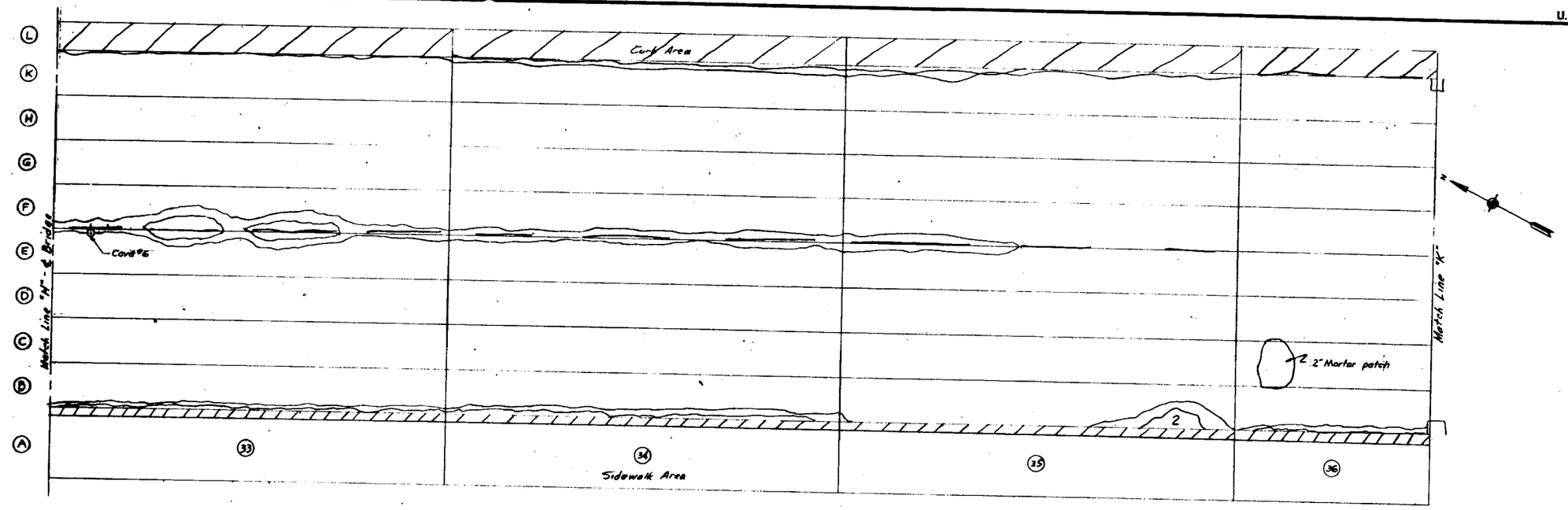
JOSEPH A. McELROY CHIEF CONCRETE SECTION

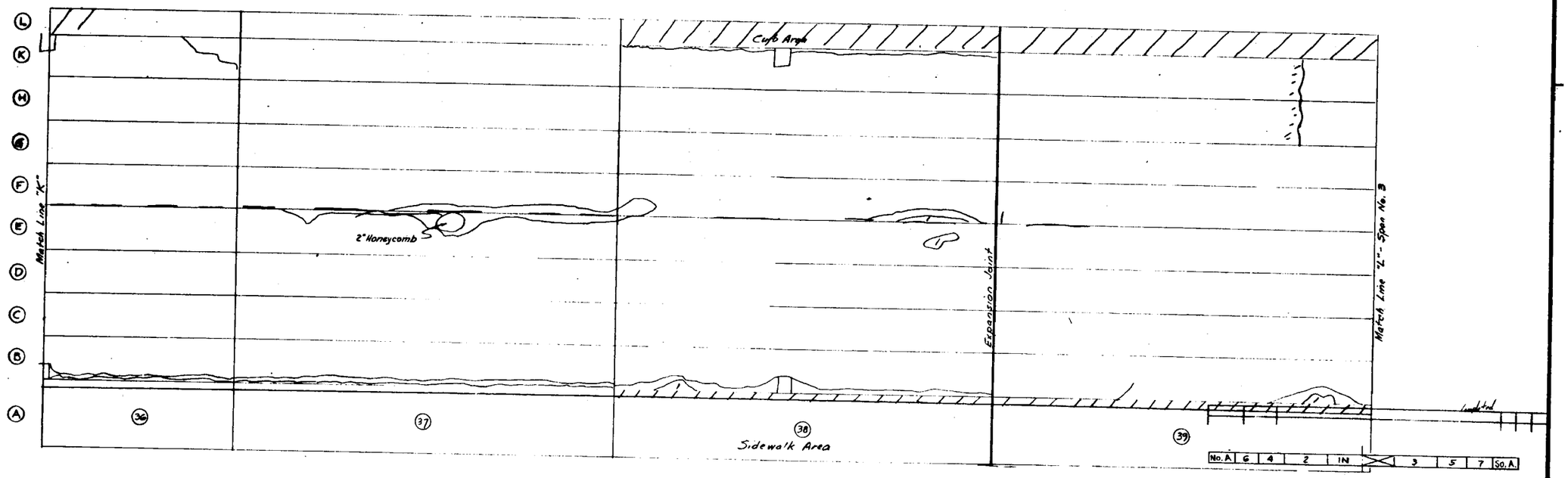
WILLIAM PALMER, MACHINIST

PLATE NO. D-5

CORPS OF ENGINEERS

U. S. ARMY





CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO.1-SOUTH

1962—1963

GRAPHIC SCALE

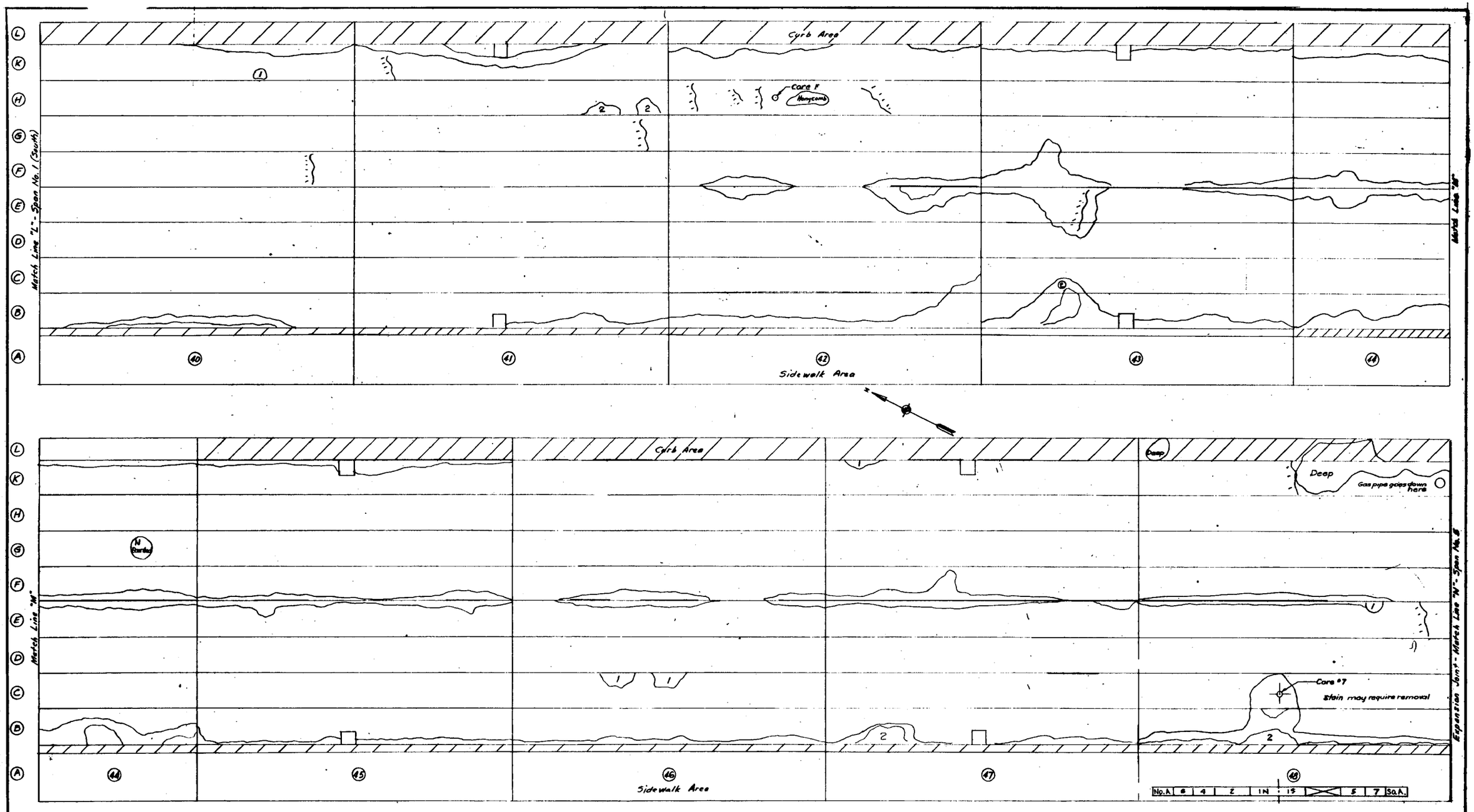
SCALE 1"=5' 5 0 5 10

PERFORMED BY

JOSEPH A. McELROY CHIEF CONCRETE SECTION

WILLIAM PALMER, MACHINIST

PLATE NO. D-6



CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO. 3

1962—1963

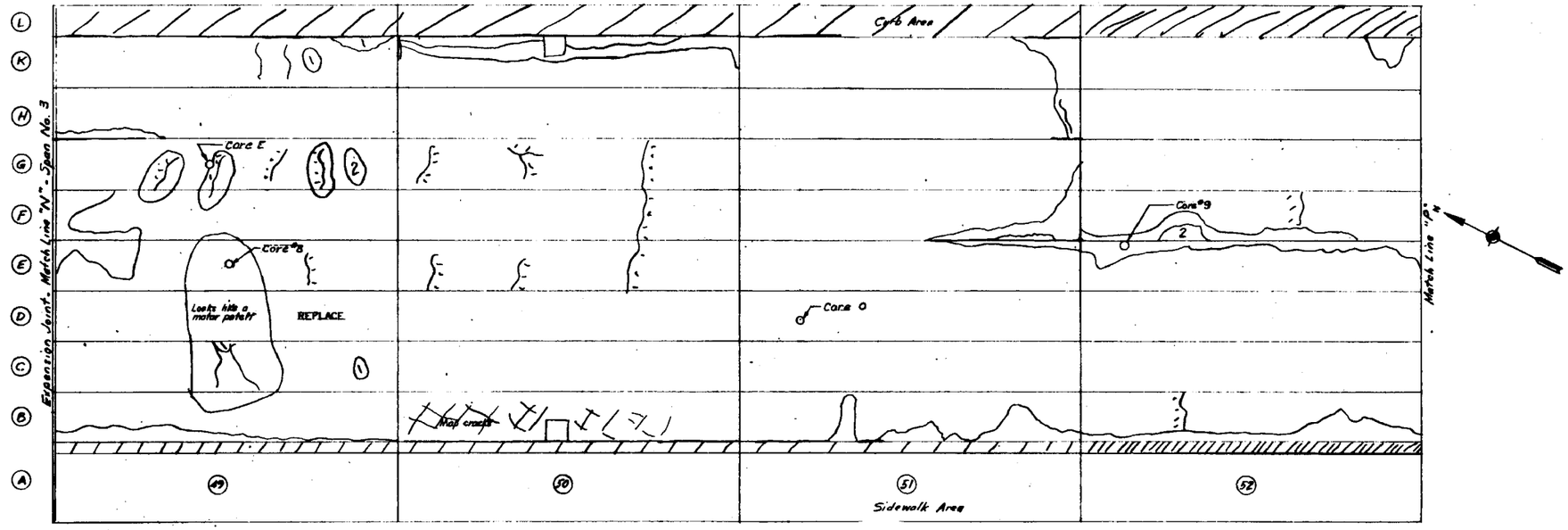
GRAPHIC SCALE

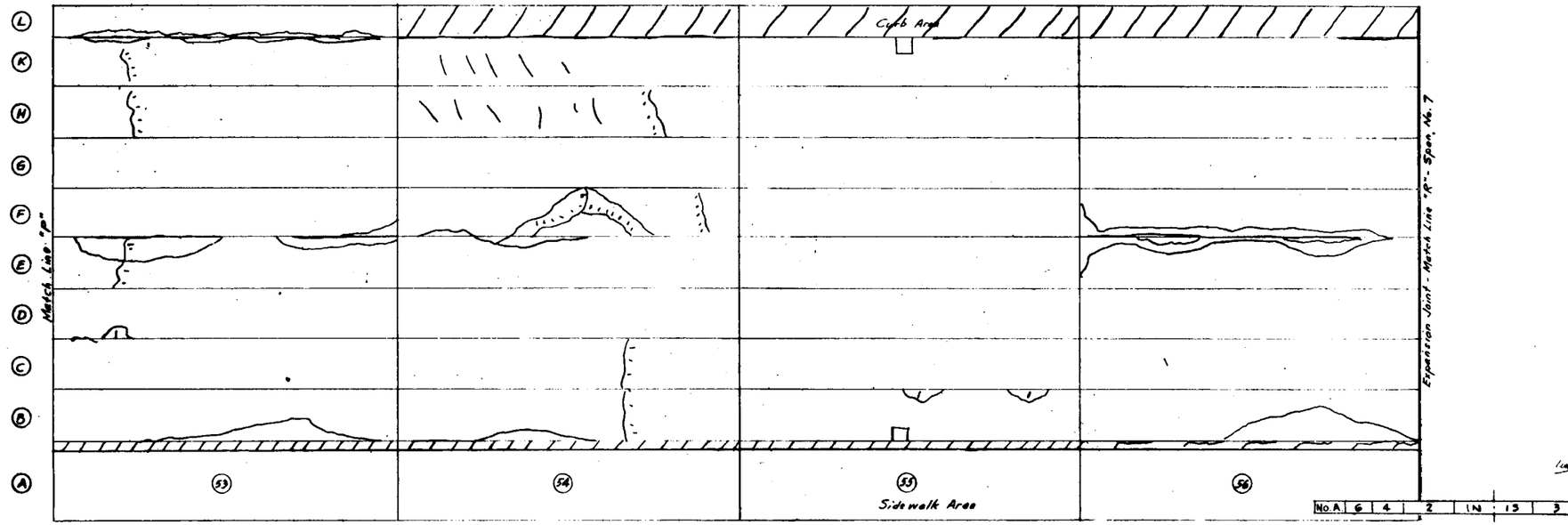
SCALE 1"=5' 5' 0 5' 10'

PERFORMED BY

JOSEPH A. McELROY CHIEF CONCRETE SECTION
WILLIAM PALMER, MACHINIST

PLATE NO. D-7





Completed

NO. A 6 4 2 IN 1 3 5 7 SO. A

CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO. 5

1962–1963

GRAPHIC SCALE

SCALE 1"=5' 5' 0 5' 10'

PERFORMED BY

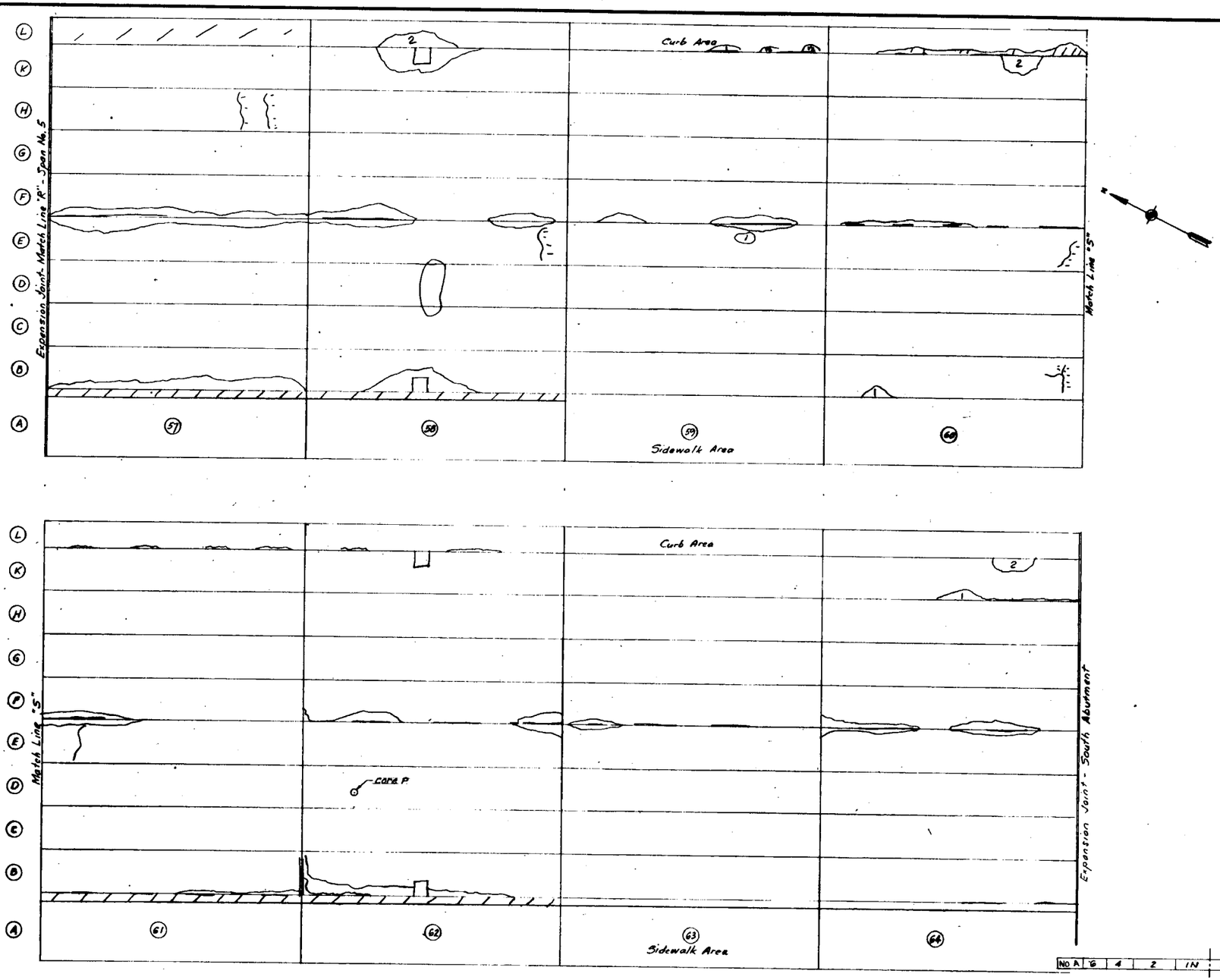
JOSEPH A. McELROY CHIEF CONCRETE SECTION

WILLIAM PALMER, MACHINIST

PLATE NO. D-8

CORPS OF ENGINEERS

U. S. ARMY



CAPE COD CANAL

BOURNE, MASSACHUSETTS

CONDITION SURVEY

BOURNE HIGHWAY BRIDGE

SPAN NO.7

1962—1963

GRAPHIC SCALE

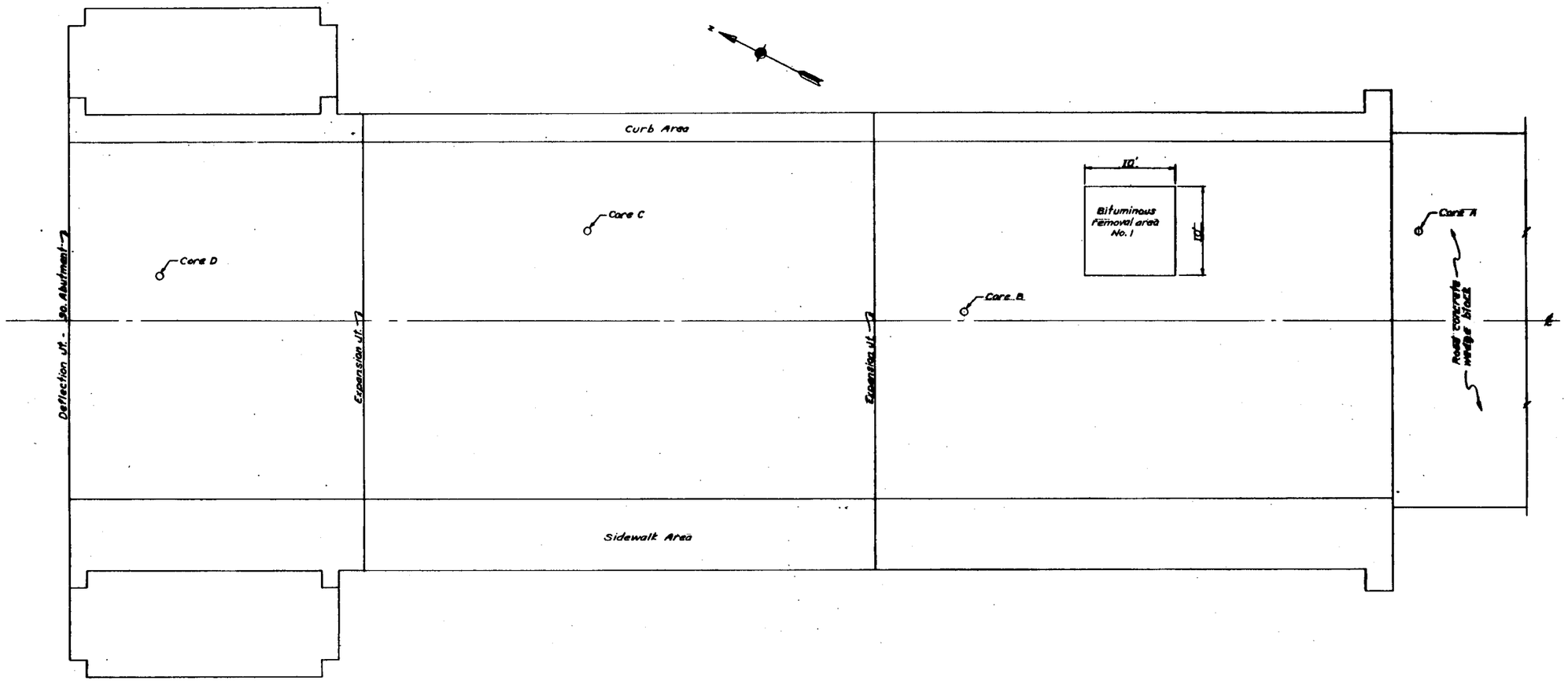
SCALE 1"=5' 5' 0 5' 10'

PERFORMED BY

JOSEPH A. McELROY CHIEF CONCRETE SECTION

WILLIAM PALMER, MACHINIST

PLATE NO. D-9



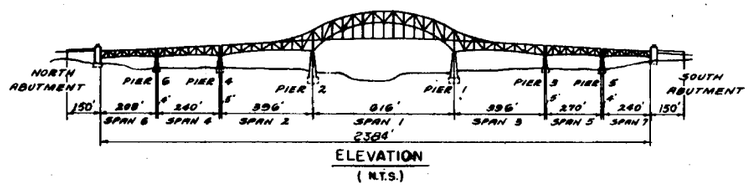
CAPE COD CANAL
BOURNE, MASSACHUSETTS
CONDITION SURVEY
BOURNE HIGHWAY BRIDGE
SOUTH ABUTMENT
1962–1963

GRAPHIC SCALE
SCALE 1"=5' 5' 0 5' 10'

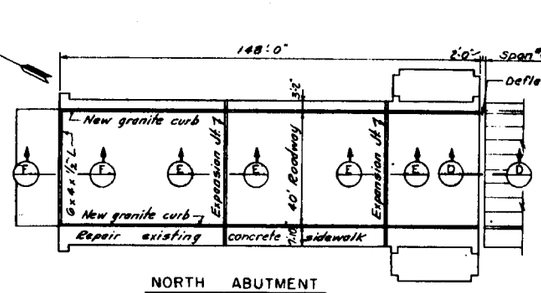
PERFORMED BY
JOSEPH A. McELROY CHIEF CONCRETE SECTION
WILLIAM [illegible], MACHINIST

PLATE NO. D-10

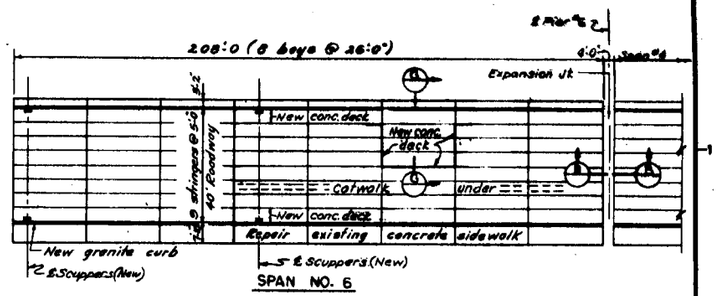
CORPS OF ENGINEERS — U. S. ARMY



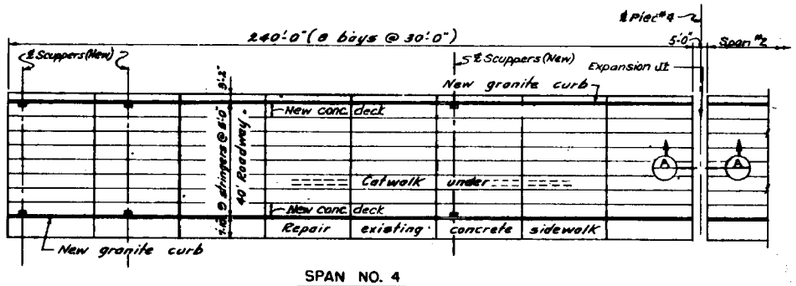
ELEVATION
(N.T.S.)



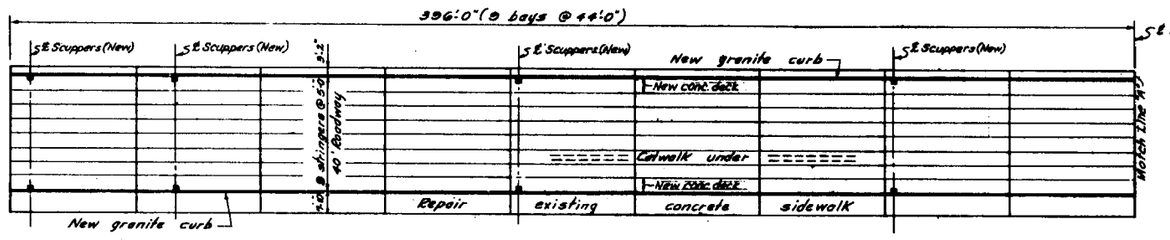
NORTH ABUTMENT



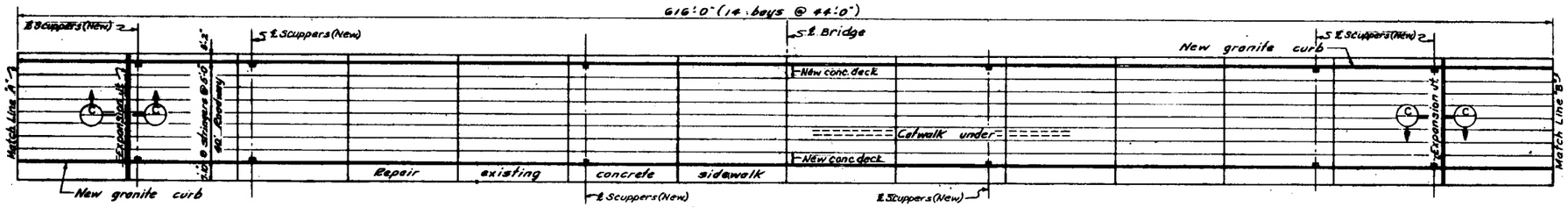
SPAN NO. 6



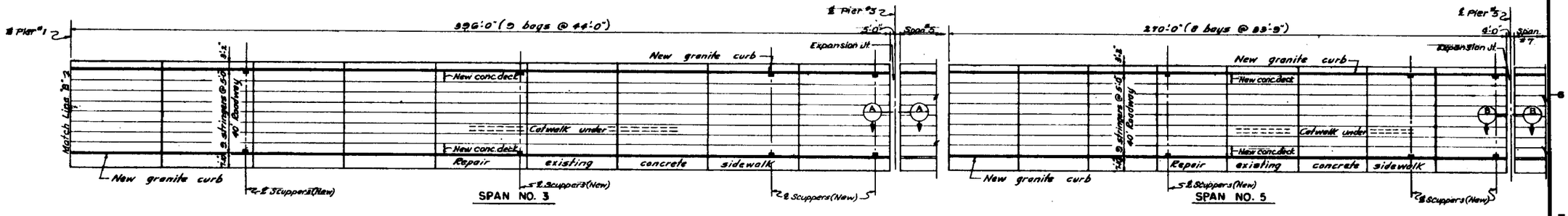
SPAN NO. 4



SPAN NO. 2

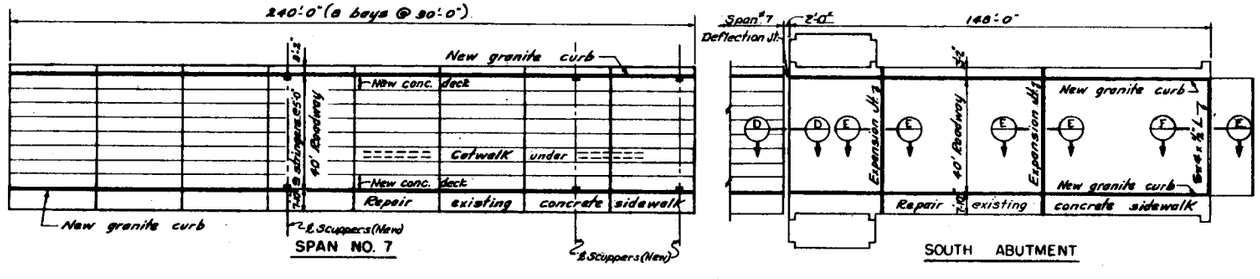


SPAN NO. 1



SPAN NO. 3

SPAN NO. 5



SPAN NO. 7

SOUTH ABUTMENT

GRAPHIC SCALE
1" = 20'
20' 0 20' 40'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CMA

DES. BY | DR. BY | CH. BY
QUANTITIES
CHIEF, SECTION
PROJECT ENGINEER
APPROVAL RECOMMENDED
APPROVAL RECOMMENDED
CHIEF, B.E.D.

CAPE COD CANAL
BOURNE, MASSACHUSETTS
BOURNE HIGHWAY BRIDGE
MAJOR REHABILITATION
DECK PLAN

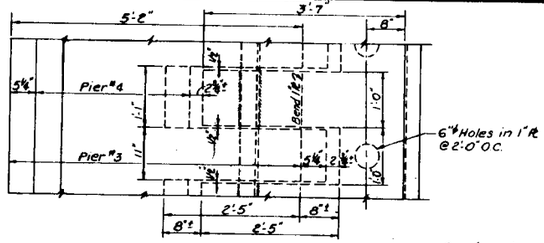
APPROVED
DATE OCT. 1963
CHIEF, ENGINEERING DIVISION

SCALE: 1" = 20' | SPEC. NO. CIV. ENG. 19-010-
DRAWING NUMBER
SHEET

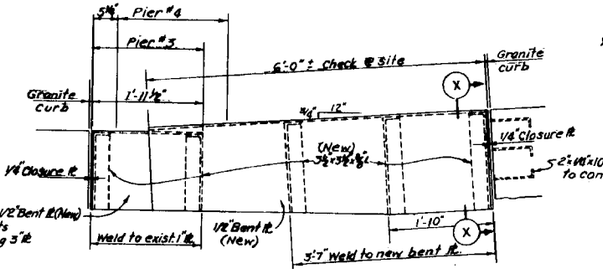
PLATE NO. E-1

CORPS OF ENGINEERS

U. S. ARMY



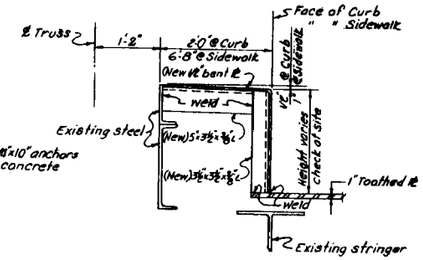
PLAN



ELEVATION-CURB & SIDEWALK EXPANSION JOINTS

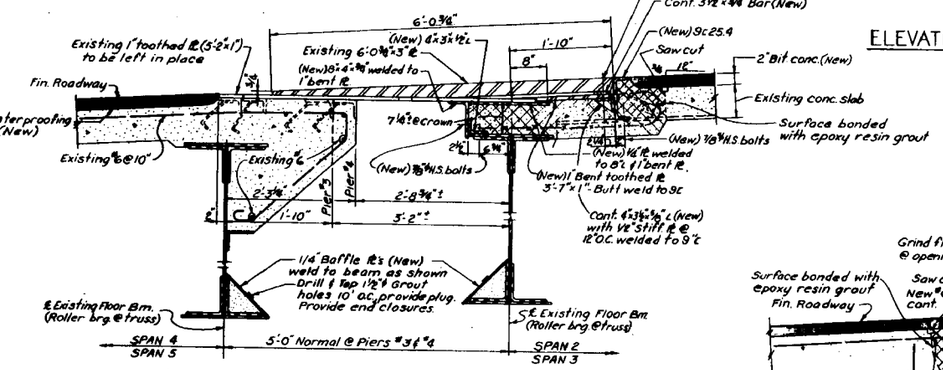
PIERS #3 & #4

SCALE: 1" = 1'-0"



SECTION X-X

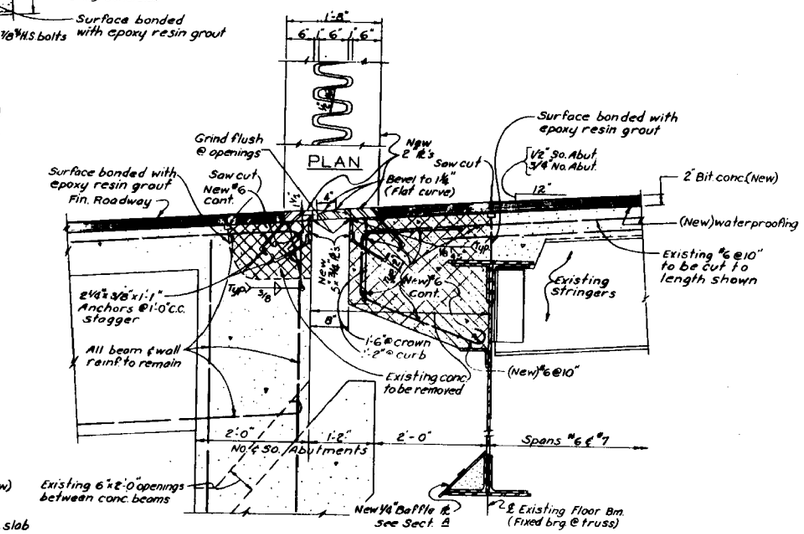
SCALE: 1" = 1'-0"



EXPANSION JOINT

SECTION (A)

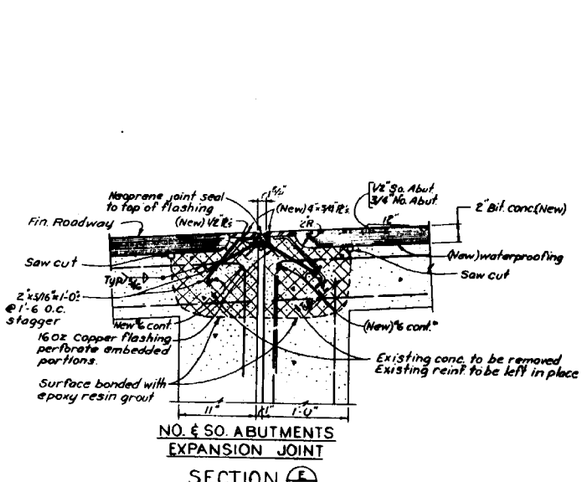
SCALE: 1" = 1'-0"



DEFLECTION JOINT

SECTION (D)

SCALE: 1" = 1'-0"

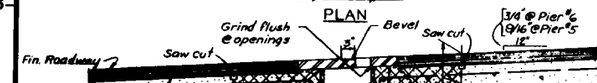


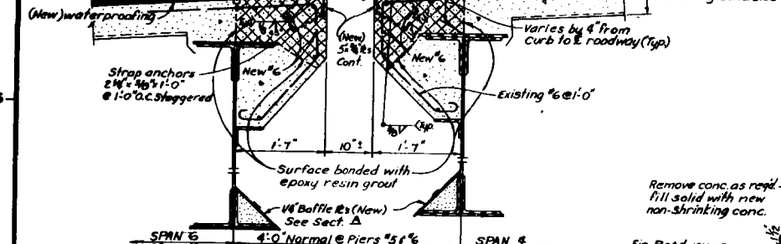
NO. 6 SO. ABUTMENTS

EXPANSION JOINT

SECTION (E)

SCALE: 1½" = 1'-0"

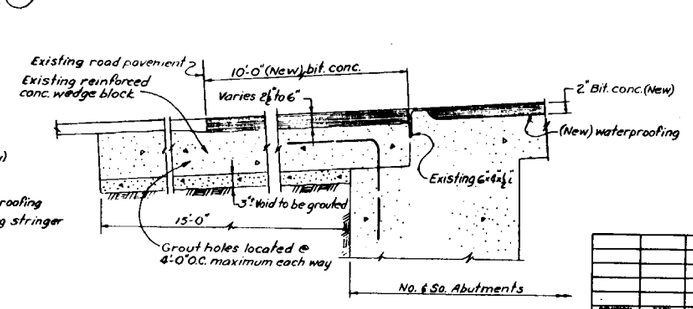




EXPANSION JOINT

SECTION (B)

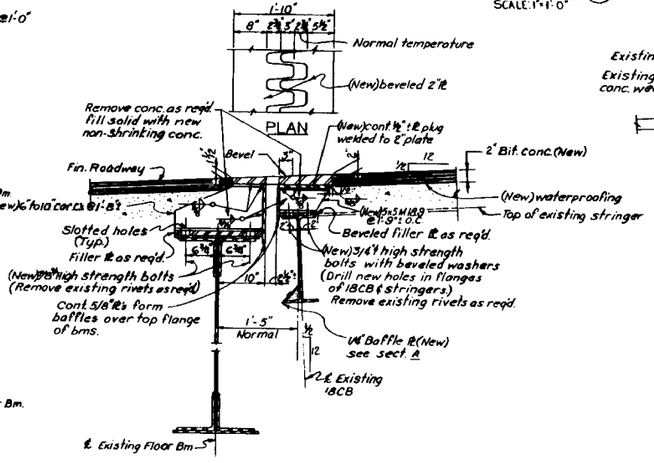
SCALE: 1" = 1'-0"



APPROACH SLAB

SECTION (F)

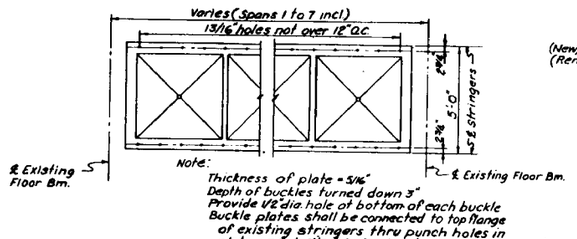
SCALE: 1" = 1'-0"



EXPANSION JOINT

SECTION (C)

SCALE: 1" = 1'-0"



BUCKLE PLATE

SCALE: 3/8" = 1'-0"

GRAPHIC SCALES

3/8" = 1'-0" 4' 0 4'

1" = 1'-0" 1' 0 1' 2'

DIVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY	DR. BY J.P.H.	CK. BY

SUBMITTED:
CHIEF, SECTION
REVIEWED:
PROJECT ENGINEER
APPROVED:
CHIEF, DESIGN BRANCH

CAPE COD CANAL.

BOURNE, MASSACHUSETTS

BOURNE HIGHWAY BRIDGE
MAJOR REHABILITATION
STRUCTURAL

STEEL DETAILS AND MISC. METALS

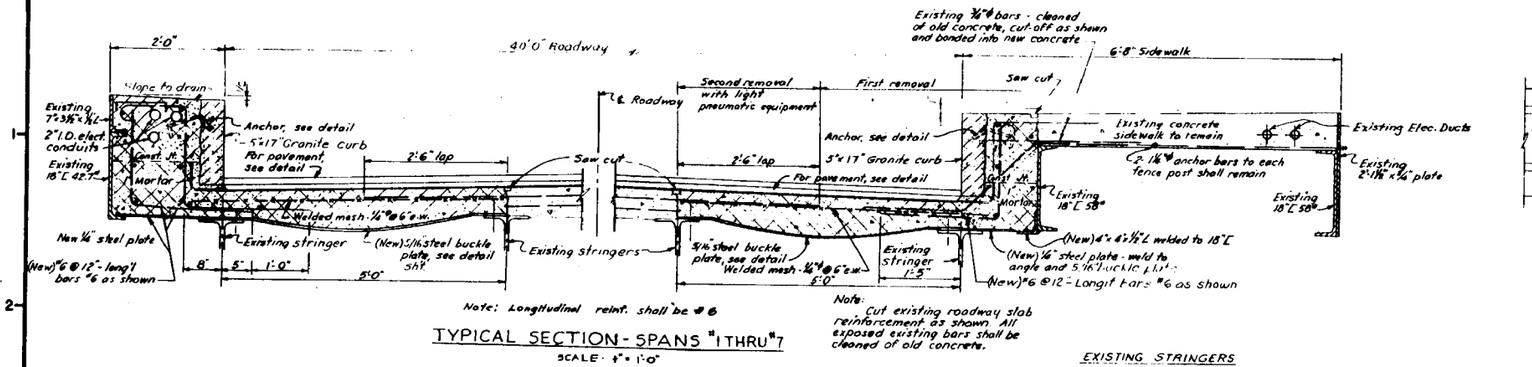
APPROVED
DATE OCT. 1963
CHIEF, ENGINEERING DIVISION

SCALE: AS SHOWN | SPEC. NO. CIV. ENG. 19-016-
DRAWING NUMBER

SHEET

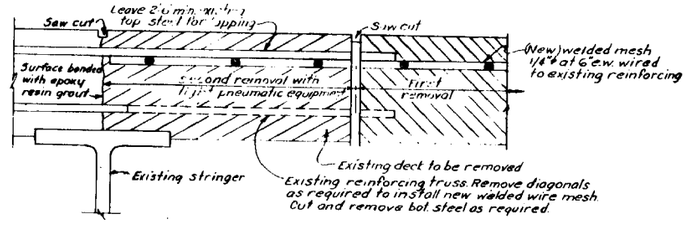
PLATE NO. E-2

CORPS OF ENGINEERS — U.S. ARMY



TYPICAL SECTION - SPANS #1 THRU #7

SCALE: 1" = 1'-0"

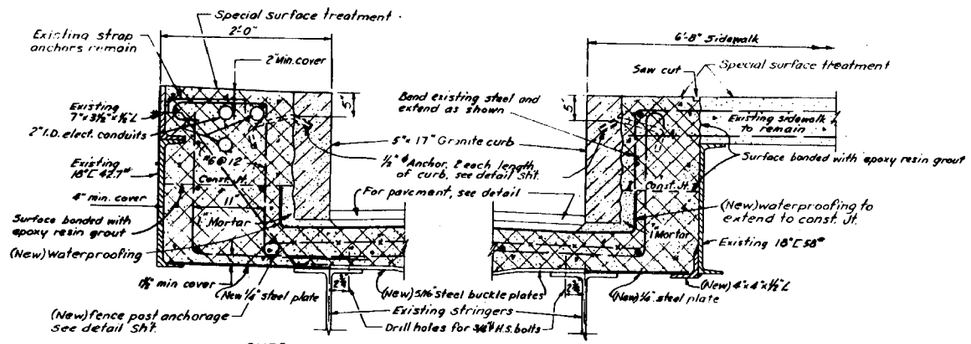


CONCRETE DEMOLITION DETAIL - SPANS #1 THRU #7

NOT TO SCALE

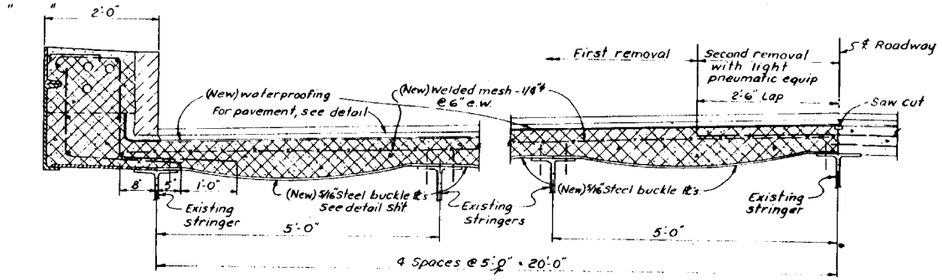
EXISTING STRINGERS

Spans 1,2,3 – 27"CB97 - Silicon steel
" 4,7 – 27"CB85 – Carbon "
" 5 – 27"CB97 – " "
" 6 – 24"CB81 – " "



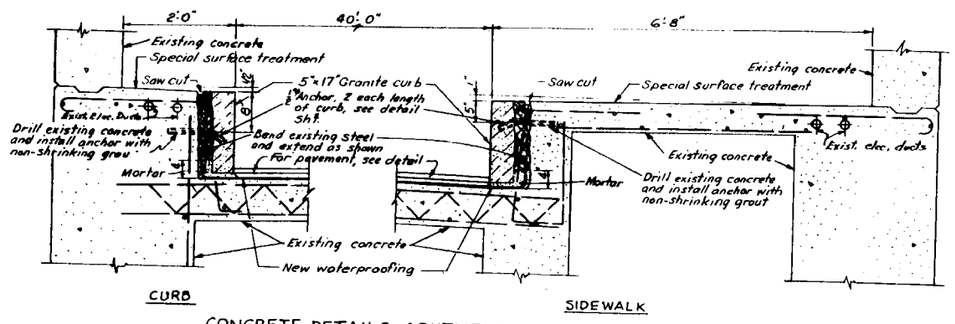
CONCRETE DETAILS - SPANS #1 THRU #7

SCALE: 1½" = 1'-0"



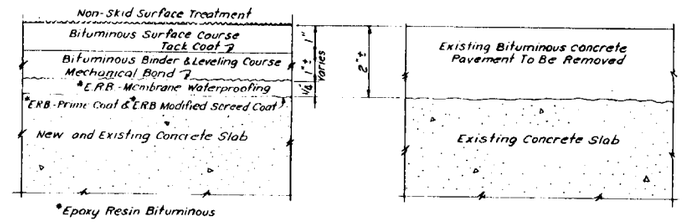
SECTION G-G

SCALE: 1" = 1'-0"



CONCRETE DETAILS - ABUTMENTS

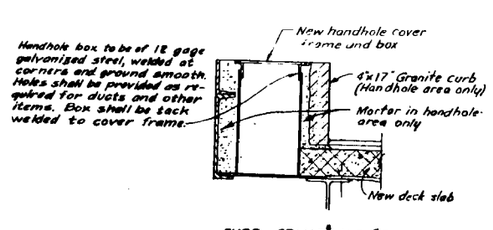
SCALE: 1" = 1'-0"



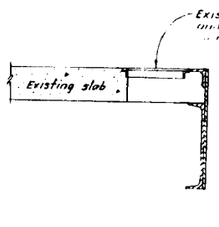
PAVEMENT DETAILS

SPANS #1 THRU #7 & ABUTMENTS

NOT TO SCALE



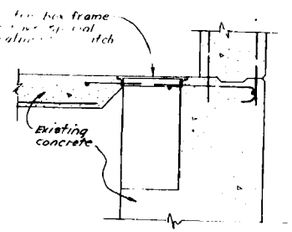
CURB - SPANS #1 THRU #7



SIDEWALK - SPANS #1 THRU #7

HANDHOLE AREAS

SCALE: 1" = 1'-0"



SIDEWALK - ABUTMENTS

Note: Abutment similar

LEGEND

- Existing Concrete To Remain
- Existing Lightweight Concrete To Be Removed And Replaced With Lightweight Concrete
- New Dense Concrete
- Existing Dense Concrete To Be Removed And Replaced With New Dense Concrete

GRAPHIC SCALES

1" = 1'-0" (1, 0, 1, 2')

1½" = 1'-0" (12", 9", 6", 3", 0, 6", 12")

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY | DR. BY S.K.P. | CK. BY

SUBMITTED:

CHIEF, SECTION

REVIEWED:

CHIEF, DESIGN BRANCH

APPROVED:

CHIEF, ENGINEERING DIVISION

APPROVED:

DATE: OCT. 1963

CAPE COD CANAL
BOURNE, MASSACHUSETTS
BOURNE HIGHWAY BRIDGE
MAJOR REHABILITATION
STRUCTURAL
CONCRETE SECTIONS AND DETAILS

SCALE: AS SHOWN | SPEC. NO. CIV. ENG. 19-010-

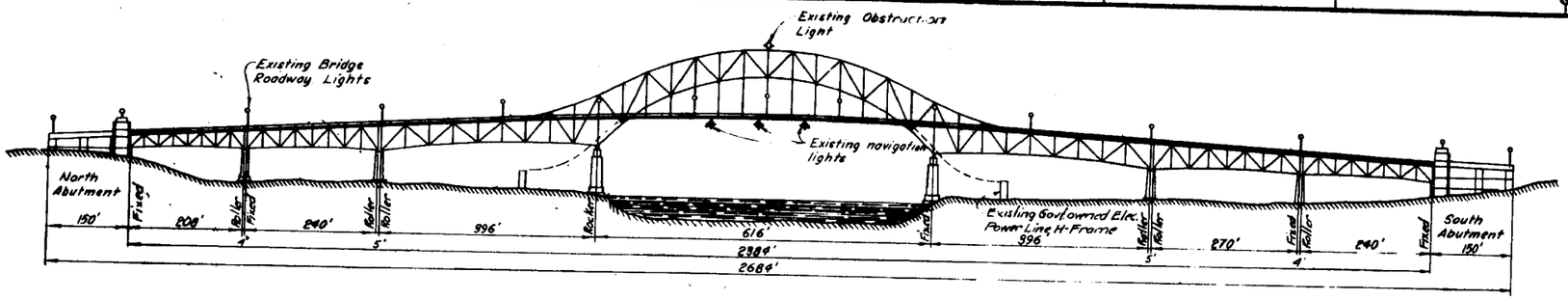
DRAWING NUMBER

SHEET

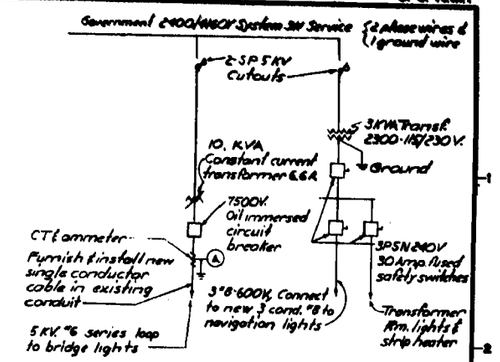
PLATE NO. E-3

CORPS OF ENGINEERS

U. S. ARMY

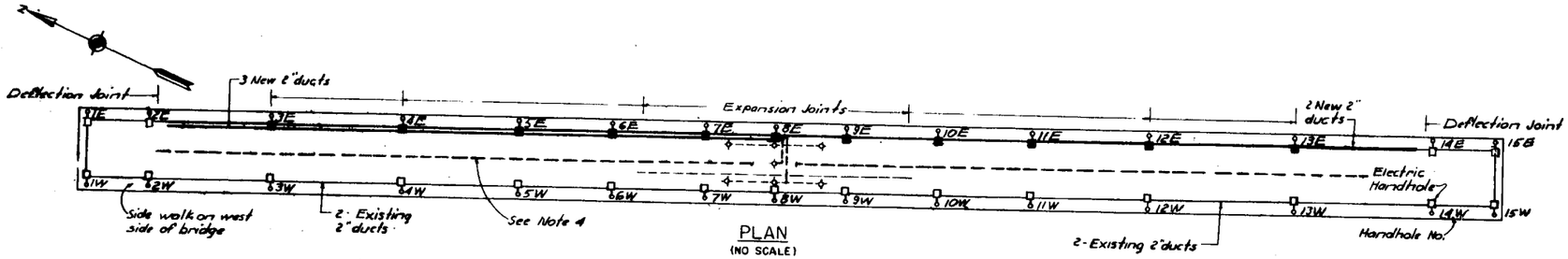


ELEVATION
SCALE: 1"=100'



ONE LINE DIAGRAM

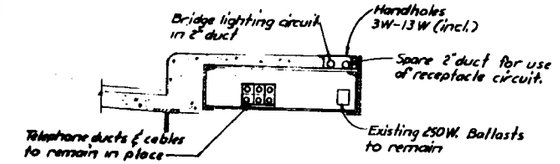
(All above equipment & wiring is located in North Pylon, Transformer Room & is existing except as otherwise indicated.)



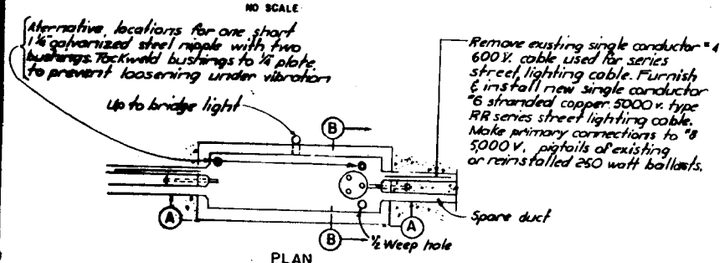
PLAN
(NO SCALE)

LEGEND

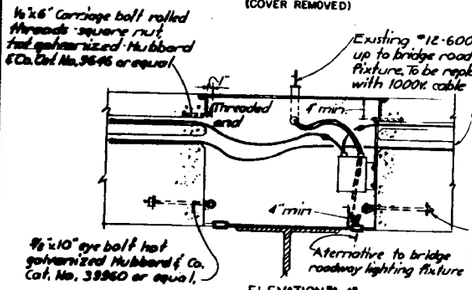
NEW	EXISTING	DESCRIPTION
	○	Bridge roadway light
	⊖	Obstruction & Navigation lights
■	□	Electric handhole
———	———	Ducts & cables
- - - - -	- - - - -	Wires or cables run other than in ducts & below bridge floors



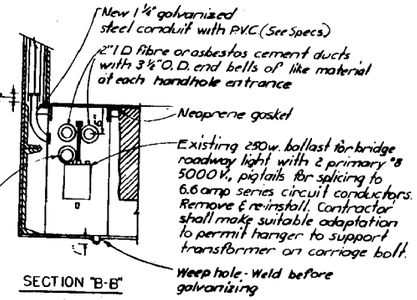
TYPICAL SECTION
EXISTING WEST SIDE ELECTRICAL DUCTS
NO SCALE



PLAN
(COVER REMOVED)



ELEVATION "A-A"



SECTION "B-B"

TYPICAL ELECTRICAL HANDHOLE
EAST SIDE CURB
NO SCALE

NOTES

1. Contractor shall connect the new conductors to existing navigation & obstruction lighting conductors at the north pylon & at handhole 8E using #8-600 V. type RR conductors & suitably supported 1½" galvanized steel conduit P.V.C. coated.
2. Contractor may obtain necessary temporary construction power for concrete, saws, wire brushes, etc. & for supplementary construction lighting from Plymouth County Electric Co. on the north side of Canal or from Cape & Vineyard Electric Co. on the south. Contractor shall furnish all equipment & cables & make suitable arrangements.
3. For structural details of handholes & expansion joints see Sheets 2 & 3.
4. Contractor shall make temporary installation of approximately 2500' of single conductor #6 5000 volt series street lighting cable to permit operation of bridge roadway lighting on eastside only or on west side only as required by renovation program. Conductor may be installed overhead, or under bridge floor.

GRAPHIC SCALE
1"=100'
100' 0 100' 200'

REVISION	DATE	DESCRIPTION	BY

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

DES. BY W.L.T. | DR. BY R.S.R | CK. BY

CAPE COD CANAL
BOURNE, MASSACHUSETTS
BOURNE HIGHWAY BRIDGE
MAJOR REHABILITATION
ELECTRICAL
PLANS, ELEVATIONS AND DETAILS

APPROVED
DATE OCT. 1963

SCALE AS SHOWN | SPEC. NO. CIV ENG 10-060-
DRAWING NUMBER
SHEET

PLATE NO. E-4